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The New Chicago Terminal Station of the Chicago & Northwestern Ry.

One of the latest examples of large passenger stations in this country is the new Chicago terminal station of the Chicago & Northwestern Ry., which was opened to traffic on June 3, 1911. This railway operates at its terminal a larger passenger traffic than any other railway entering Chicago, and has about the largest number of passenger trains handled at any of the terminal stations in that city. The present number of its inbound and outbound trains is about 300 daily, and about 60% of the trains are in suburban service. It may be noted, also, that this is the only railway having a terminal station for its own exclusive use; the other five teminals in Chicago are used by three or more railways each. The location of the several terminal stations is shown in Fig. 2.

The old terminal station of this road at Kinzie and Wells Sts. has long been outgrown by the traffic, although it has been enlarged at different times by the purchase of additional land for tracks and platforms. Its accommodations for passengers also were limited and not in accordance with modern requirements. Further extension was prevented, however, by a public street along one side and the river on the other side of the property. In addition to this, the station had the objectionable feature of requiring two drawbridge crossings for passengers. Close to the end of the station yard the railway crossed the north branch of the Chicago River by a bascule bridge,* while a great majority of the passengers had to cross the main stem of the river in going to and from the stations.

The question of a new station and a new site was under consideration for some years, and in 1905 it was decided to build the station which has just been completed. The original project was outlined in our issue of Oct. 18, 1906. This new station is estimated to be capable of handling 1,200 regular trains daily, so that it makes ample provision for future growth of the traffic. The view herewith shows the Madison St. front and Canal St. side of the station.

*Engineering News, Nov. 24, 1910.

THE NEW CHICAGO PASSENGER TERMINAL STATION OF THE CHICAGO & NORTHWESTERN RY. (MADISON ST. FRONT).

Edward C. Carter, M. Am. Soc. C. E., Chief Engineer. W. C. Armstrong, M. Am. Soc. C. E., Terminal Engineer. Frost & Granger, Architects.

Table I. gives a comparison of this station with some other large stations of the same class, and it will be noted that it ranks sixth according to the number of station tracks (ranking with the Philadelphia terminal of the Pennsylvania R. R.), and seventh according to the number of regular trains daily. The last column of this table is of interest in showing the approximate number of daily movements in several large stations. The handling of empty trains into and out of the station practically doubles the number of regular train movements, and, in addition, there are various light engine and switching movements which increase the total very considerably.

In regard to the location of railway passenger terminals, it has been claimed that for very large cities it is desirable to locate the stations in the outskirts (where land is less expensive), leaving the distribution of passengers to local transportation systems. This idea does not appear to be in favor among the railway officers who have the power of deciding the location, and who have evidently a strong belief in the strategic and commercial advantages of a conspicuous and centrally located terminal station. Such a location is of special advantage in this case, owing to the heavy suburban traffic, since it enables a large proportion of the suburban passengers to walk to and from the station and their places of business.

The new station is located one block west of the river, so that it has no drawbridge to interfere with train movements. The main front is on the north side of Madison St., between Canal and Clinton Sts., and the station extends four blocks north to Milwaukee Ave., covering an area of about eight acres. The train floor is elevated above the street level, and is carried across intersecting streets by steel bridges. There are two four-track elevated approaches, one for the Galena Division (from the west) and one for the Wisconsin Division (from the north). These converge upon a six-track approach, from which the tracks diverge to the station yard and trainshed.

The main building is 320 × 218 ft., while the trainshed and station yard occupy a space 320 × 1,072 ft. The right-of-way acquired for the station and approaches aggregated 37 acres, of which 20 acres were covered with buildings; there were 455 buildings wrecked or moved, 66 of these being four stories or more in height. The station and approaches necessitated the bridging of 40 streets and 13 alleys.

At the point where the station crosses Washington St. is the inclined approach to the Washington St. tunnel of the street railway system, and this necessitated special arrangements of the columns and foundations. The carrying of the elevated approach across Lake St. necessitated the raising of the Chicago & Oak Park Elevated Ry., and the substitution of a truss span (across the approach) for the shorter plate-girder spans of the elevated structure at this point. The work for the tunnel and for the alterations to the elevated railway were described in our issues of July 21, 1910, and Dec. 9, 1909, respectively.

Some idea of the extent of the work may be gathered from Table II., which includes both the station and the approaches.

The entire work of design and construction was under the supervision of Mr. Edward C. Carter, M. Am. Soc. C. E., Chief Engineer of the Chicago & Northwestern Ry.; the execution of the work was under the direct charge of Mr. W. C. Armstrong, M. Am. Soc. C. E., Terminal Engineer. The signal and interlocking plant was designed by Mr. J. A. Peabody, Signal Engineer. The architects for the building were Frost & Granger, and E. C. & R. M. Shankland were the structural engineers for the architects. Pierce Richardson & Neiler were the mechanical and

TABLE II.—SUMMARY OF WORK ON THE CHICAGO TERMINAL STATION, CHICAGO & NORTHWESTERN RY.

Area of right of way	37 acres.
Excavation	250,000 cu. yds.
Piles driven; No. 43,000	1,530,000 lin. ft.
Concrete	265,000 cu. yds.
Structural steel in station and in street bridges	37,000 tons.
No. of foundation piers	316
Paving	42,800 sq. yds.
Concrete sidewalk	25,000 sq. yds.
Curbing	22,000 lin. ft.
Waterproofing	74,000 sq. yds.
Length of tracks: Terminal sect.	34,500 ft.
West approach	26,700 ft.
North approach	33,500 ft.
Total (18 miles)	94,500 ft.
Cost: Real estate & legal proceedings	$11,560,000
Station building and trainshed	6,380,000
Power station and equipment	810,000
Elevated approaches	5,000,000
Total	23,750,000
Work commenced. Clearing site	Nov., 1906
Construction of approaches	Sept., 1908
Construction of station	Nov., 1908
Erecting steel	Feb., 1909
Station opened for traffic	June 3, 1911

electrical engineers. The principal contractors were as follows: foundations, masonry and station building, the Geo. A. Fuller Co.; steel work, American Bridge Co.; erection of steel work of trainshed and bridges, Strobel Steel Construction Co.; foundations and concrete work of terminal section, Geo. W. Jackson; concrete work of north and west approaches, Bates & Rogers Construction Co. and J. J. O'Heron Co., respectively. The filling of the solid portion of the approaches and the laying of all track work was done by the railway company's engineering department.

Foundations.

The character of the soil at the station site is that which occurs mainly in the business portion of Chicago. The top layer of filled material was underlaid by soft muck and then by a bed of blue clay; the clay is mainly stiff, but soft in places, and has occasional pockets of quicksand. Hardpan occurs at about 85 ft., and solid rock at 115 to 120 ft. below the street level. The whole area from Madison St. to Milwaukee Ave. was first excavated to a depth of about 8 ft. below the street level, the excavation being made deeper where required for basements, pump pits, elevator shafts, etc.

The main foundations consist of concrete piers (or so-called caissons) built in open wells or shafts in the manner now customary for large buildings in Chicago. For the lighter loads of the interior columns carrying the trainshed, pile clusters are used under each footing. These piles are about 50 ft. long and spaced 2 ft. c. to c., and carry an average load of 18 tons per pile. The footings have a base area of 10 × 10 ft. for a single pedestal 4 × 4 ft., or 10½ × 22½ ft. for a footing carrying two pedestals. The reinforced concrete retaining walls for the deeper part of the basement of the building are about 22 ft. high; they are 2 ft. wide on top, with the back sloped to give a width of 12 ft. at the street level, while at the base the toe is extended to give a width of 17 ft. over the supporting piles. These walls are of gravel concrete 1:2:5.

The concrete foundation piers mentioned above are 216 in number with a diameter of 4 to 8 ft.; of these, 172 are under the station building, 36 under the retaining walls of the Washington St. tunnel approach, 4 under the bridge carrying the station approach over Lake St., and 4 under the smokestack of the power-house. Those under the station are spaced 32 ft. apart longitudinally and from 16 to 18 ft. transversely. More than half of the piers are founded on hardpan at a depth of about 85 ft. below the street level, but it was necessary to carry 97 of the piers to bed rock; the maximum depth of these latter piers was 120 ft. 8 ins. Four of these deep piers are under the smokestack, the others are under different parts of the station. In some of the shafts quicksand was encountered, and it was necessary to employ the pneumatic system.

The concrete for the piers, retaining walls and footings was prepared by a mixing plant installed in the excavated area, below the street level. The storage bins for material were beneath a platform at this level, so that wagons could dump stone, gravel and sand directly into them. The materials were discharged through bottom hoppers into a belt conveyor which delivered them to a bucket conveyor, by which they were raised to elevated hoppers. From these the materials were fed by gravity to measuring boxes, and then discharged directly into a drum mixer of 1 yd. capacity. The mixer delivered the concrete into steel side-dump cars running on portable tracks.

Station Building.

The station building includes not only the headhouse proper, but also the space beneath the trainshed, this latter affording convenient accommodation for many of the station facilities. This is shown by the plan, Fig. 3. The space on the first block (from Madison to Washington Sts.) includes the first floor of the headhouse and the inbound baggage room, baggage wagon driveway, and carriage entrance. In the next block (to Randolph St.) are the U. S. post-office substation, immigrants rooms, and a cab stand. Here also is a broad concourse specially for the use of suburban passengers and having stairways from the train platforms. Thus incoming passengers can go from the train platforms to the street without passing through the main part of the station. The arrangements are so planned, however, that the concourse may be adapted for use by both outgoing and incoming suburban passengers, if this should be desirable. This is likely to be the case, a request to this effect having been made already on behalf of suburban passengers coming to the station from the north end, and who have to walk all the way to the main building and then back through the station to their trains.

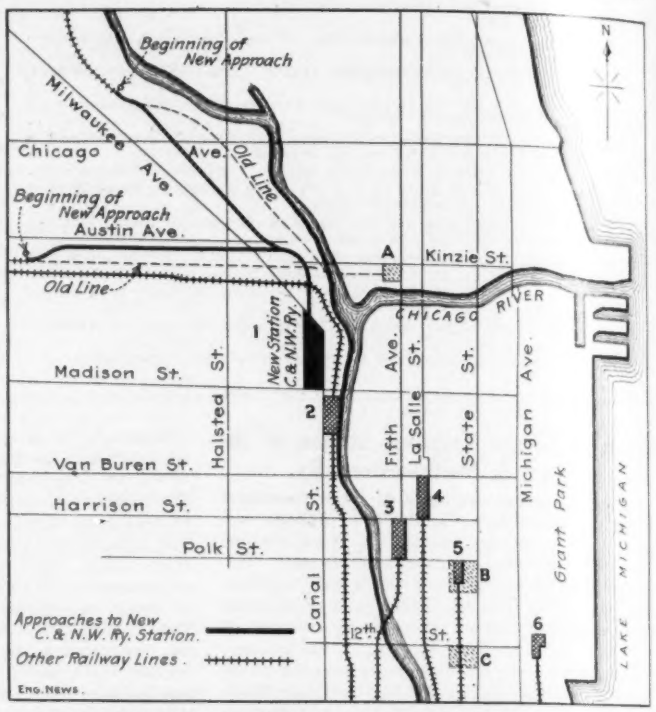

FIG. 2. MAP SHOWING THE RELATIVE POSITIONS OF RAILWAY TERMINAL STATIONS IN CHICAGO.

A.—Old Kinzie St. Station; C. & N. W. Ry. (Abandoned.)
B and C.—Proposed sites for new Dearborn Station.
1. New Station; Chicago & Northwestern Ry. (Madison St.)
2. Union Station (Adams and Canal Sts.).
3. Grand Central Station (Harrison St.)
4. La Salle Station (Van Buren St.).
5. Dearborn Station (Polk and Dearborn Sts.).
6. Park Row Station.

TABLE I.—PARTICULARS OF SOME LARGE RAILWAY STATIONS.

Stations: City.	Railway or Terminal Co.	Class.	No. of tracks in train shed.	Platforms: No.	Platforms: Length. ft.	Width of station or train shed. ft.	Daily number: Schedule trains. (in & out).	Daily number: Total movements (Estim.)*
St. Louis	Term. R. R. Assoc.	Union	32	17 (12 ft.)	810	606	322	2,010
Washington	Wash. Term. Co.	Union	31	18	900 to 1,000	760[1]	244	2,500
Boston (So. Sta.)	Bos. Ter. Co.	Union	28	{14 pass. 8 bagg.}	610 to 950	570	786	3,500[2]
Boston (No. Sta.)	B. & Me. Ry.		23	13	728	459	607	2,950
New York	Penn. R. R.		21	{11 pass. 4 bagg.}	750 to 1,130	509	392[3]	....
Chicago	C. & N. W. Ry.		16	8	740 to 840	320	300	....
Philadelphia	Pa. R. R. (Bd. St.)		16	8	680 to 1,060	306	574	3,400
Kansas City	K. C. Term. Ry.	Union	pres. 16	8	1,400	390	313 (est.)	....
			fut. 24	12	1.400	612	....	....
Cincinnati	C. Un. Dep. & Term. Co.	Proposed union.	16 (equiv. to 32[4])	8 (21 ft.)	1,400 to 1,900	355	276 (est.)	....
Hoboken	D., L. & W. Ry.		14	8 (20 ft.)	700[5]	335	263	....
Jersey City	Penn. R. R.		12	{6 pass. 2 bagg.}	790	260	334	813[6]
Chicago (La Salle Sta.)	C., R. I. & P. Ry.	Union	11	6	578	207	....	....
Chicago (Union Sta.)	Penn. Lines[7]	Union	{3 thro. 6 stab.}	4 pass. 2 mail	500 to 1,500	{66 middle 132 ends}	270	1,400
New York; Grand Central Station (New York Central Ry.)		upper floor	42	16	16,415 total	820	422	694
		lower floor	22	17	14,380 total	578	57	117
		total	64	33	30,795 total	...	479	811

*Total number of movements includes schedule and empty trains, light locomotives and switching movements.
[1]Washington. No trainshed; platform shelters 355 ft. long.
[2]Boston (South Station). Regular and empty trains number 1,450 movements; switching movements, etc., bring the total to 3,500 or 4,000 movements.
[3]New York (Pennsylvania R. R.). The empty trains bring the train movements to 681.
[4]Cincinnati. This proposed union station would be operated from each end (like the Union Station at Chicago), so that the 16 tracks would be equivalent to 32 station or train tracks.
[5]Hoboken. The platforms are 700 ft. long, with 600 ft. covered by a trainshed of the Bush type.
[6]Jersey City. Including empty trains the number of train is 668. Before the New York station was opened the total number of movements was 813 per day.
[7]Chicago (Union Station). This is a double-end station, with no through trains. Therefore, two trains (of different roads) can occupy each through track simultaneously, pulling out in opposite directions.

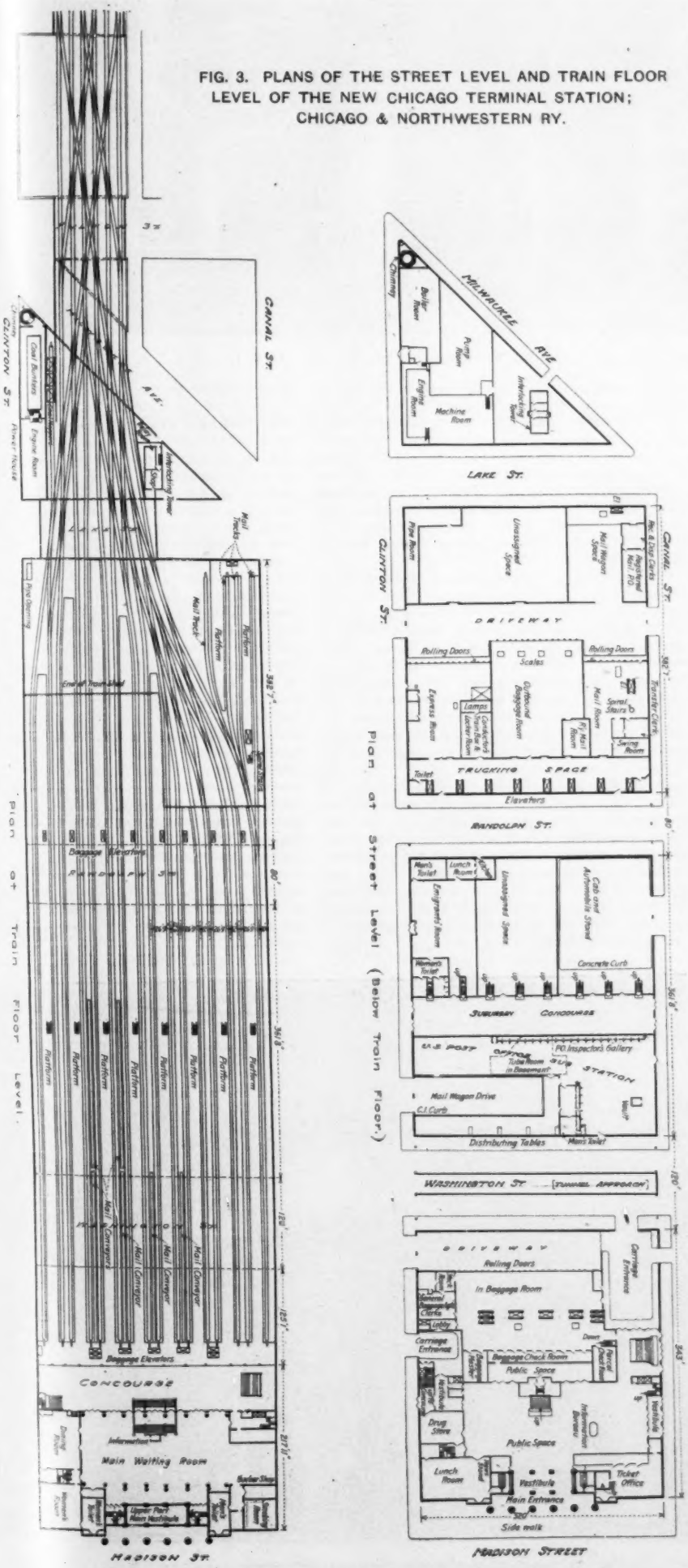

FIG. 3. PLANS OF THE STREET LEVEL AND TRAIN FLOOR LEVEL OF THE NEW CHICAGO TERMINAL STATION; CHICAGO & NORTHWESTERN RY.

In the third block (to Lake St.) are the outbound baggage room, driveway for baggage wagons, express room, mail room, etc.; the mail room has elevators serving the platforms of short stub tracks for mail cars. The fourth block (to Milwaukee Ave.) is triangular in shape; this contains the power-house, and also the lower floor of the main signal tower. These accommodations, it will be understood, are at the street level.

We return now to the main building or headhouse, shown in Fig. 2. This is a four-story granite structure 320 × 218 ft., and is devoted entirely to accommodation for passengers and for the officers required in the station service and the handling of trains. No attempt was made to provide general offices for the railway company, as the company has its own 14-story office building for this purpose. The station building has a frontage of 320 ft. on Madison St., and the first floor has a depth of about 343 ft.; on the upper floors, however, the depth is only a little over 200 ft.

The architectural design is simple, and is in the style of the Italian renaissance. The feature of the main front on Madison St. is a portico extending the height of three stories, and having its street front formed by a row of six granite columns 7 ft. diameter at the base and 61 ft. high. Flanking the top of the portico are two small turrets or cupolas, each having clock faces 12 ft. diameter. Three lofty arched openings give access to a vaulted vestibule 132 × 22 ft., with a height of 40 ft. On the Canal St. and Clinton St. sides are less elaborate entrance vestibules, and at these entrances there are canopies extending over the sidewalk, for the protection of passengers going to and from cabs or omnibuses in bad weather. There is also, however, a carriage space within the station. The three vestibules open into a large open space, and all have broad stairways leading either to the main waiting room or to the concourse between this room and the trainshed. Elevators also are provided. The lighting and ventilating equipment is very complete, and the lighting of the waiting rooms includes indirect lighting (by concealed lights along the cornice) in addition to the usual clusters of exposed lights.

Around the large open space on the first floor are arranged the ticket office, parcels room, telegraph offices, lunch room, etc. This open space or entrance hall is shown in Fig. 4, with the doors to the Madison St. vestibule in the right and the main stairway to the concourse at the left. The photograph gives an appearance of gloominess, but as a matter of fact the hall is very light, and the coloring (green and cream color tile) is much lighter and brighter than might be supposed from the view. At the north end are the baggage checking counter and the inbound baggage room, with elevators to the train platforms. As noted already, there are two separate baggage rooms. The one for inbound baggage is at the south end, convenient to the head of incoming trains; the one for outbound baggage is near the north end, conveniently located to serve the head of outgoing trains. In this way the amount of trucking along the platforms is reduced considerably. The rooms are connected by a pneumatic conveyor system, having oval pipes 3 × 6 ins. for the transfer of baggage checks, etc., all business with passengers being transacted at the counter of the inbound baggage room in the main part of the station building.

On the second floor of the station (20 ft. above the street level) are the main waiting room, women's rooms, smoking room, dining room and toilet rooms. The waiting room is about 200 × 120 ft., with a height of 85 ft.; it has a barrel-vaulted roof extending above the main roof of the building and having clerestory windows. This room is shown in Fig. 5; at the left are the main stairway and the doors opening upon the concourse. The third and fourth floors are at the sides of the building only, the waiting room occupying the entire central space. On the third floor are the offices of the division engineers, superintendents, train dispatchers, etc.; also the barbers' shop and bath and toilet rooms.

FIG. 4. MAIN HALL OF CHICAGO TERMINAL STATION, C. & N. W. RY.

Here also is the matron's room and a rest room for women who may be sick or may have to wait for some considerable time, and can thus have more quiet than is afforded by the accommodations on the main floor. On the fourth floor are the telephone exchange and offices for the electrical engineers, sleeping car officials, etc., also rooms for the use of the train conductors. In the basement are the kitchen, baggage store room, heating and ventilating plant, and various rooms for the employees.

The concourse (or space between the waiting room and trainshed) is 60 ft. wide and extends the full width of the building. It is unique in being formed as an enclosed space, a glazed partition shutting it off entirely from the trainshed. In most stations the concourse is simply a broad platform at the end of the train platforms, from which it is separated only by an iron fence. The enclosed arrangement will give greater comfort and convenience, and in winter it will serve to prevent drafts in the concourse and waiting room.

The building is of steel frame construction with brick walls and floors of hollow tile construction; the floor of the waiting room, however, is carried by vaulted tile arches which form the ceiling of the open space or entrance hall on the first floor. The roof is of reinforced concrete 3½ ins. thick, covered with 1-in. tile and a waterproof roofing composition. The roof of the waiting room is carried by arched trusses of 90 ft. span and 31 ft. rise, giving a clear height of 84 ft. above the floor.

Trainshed.

The trainshed is 320 ft. wide, with a length of 940 ft. from the concourse, except that on the east side it is about 200 ft. shorter (for seven tracks) in order to give room for the leads from the approach to the station tracks on this side. It is of the Bush type (patented by Mr. Lincoln Bush, M. Am. Soc. C. E.), having low short spans with a longitudinal opening above each track to carry off the smoke and gases from the locomotives. Fig. 6 is an interior view from the concourse, and shows also the baggage elevators and the heavy steel bumping posts at the ends of the tracks. Fig. 7 is a cross section of the trainshed and the structure which supports it (forming the first story of the building); Fig. 8 gives the details of construction.

There is a single row of columns in the center of each platform, the columns being spaced about 38 ft. 9 ins. transversely (c. to c. of platforms) and 25½ ft. longitudinally. These carry the plate-girder arched ribs of the roof. At each side is a half-arch span from the platform columns to columns in the side walls. The springing line of the ribs is 11 ft. above the rails, and the rise of the arch is about 5 ft. 11 ins., giving a total height at the center of 16 ft. 11 ins. above the rail level. Each column consists of a pair of 12-in. channels, with the flanges facing and connected by lacing bars. The columns are connected longitudinally by struts composed of two 10-in. channels, with a ½-in. bottom plate 18 ins. wide. Between each pair of arch ribs is a framing consisting of two I-beam rafters (bent to conform to the curve of the roof) and longitudinal purlins of 6-in. bulb angles. There are also lattice girder longitudinal struts between the ribs, so spaced as to form (with the concrete in which they are encased) the sides of the longitudinal openings over each track. In each span there are these longitudinal openings, wire-glass skylights 5 ft. wide over the platforms, and a central row of ventilators.

The longitudinal openings above mentioned are 36 ins. wide, and the concrete slabs forming their sides are 57 ins. deep. These slabs project far enough above the roof to exclude drainage water, and far enough below it to prevent driving rain or snow from reaching the platforms. Holes in the slabs prevent the pocketing of gases behind them. The roof framing is not encased in concrete, except in regard to the lattice struts of the openings, and the portions of the ribs which extend across these openings. A cast-iron shoe under this part of each rib protects the concrete covering from injury, and is about 5 ins. clear above the tops of the tallest smokestacks. The steel framing and the columns are painted a light gray color to harmonize with the concrete of the roof and smoke ducts.

Upon the steel roof framing is a 2½-in. concrete roof slab, reinforced with wire mesh near the inner face, and covered with composition roofing. The roof drainage is led to gutters in the valleys, and thence by downspouts at alternate columns to the sewer connections. A snow load of 20 lbs. per sq. ft. is assumed for the roof loading. The trainshed roof is not visible from the street, being screened by carrying the side walls above it, or to a height of nearly 50 ft. from the street. Along the inner side of one wall (above the roof) is a gallery for pipes and electric conduits. These walls are of gray brick with stone coping and string course. As there are no windows, they present a rather large unbroken area, relieved only by a little paneling. The trainshed is lighted by both arc and incandescent lamps.

The trainshed floor is carried by a steel framing with columns resting on concrete pedestals and footings with pile clusters, as described already under the head of Foundations (and shown in Fig. 7). In most cases, each footing has two pedestals and supports two columns. For each track (except two) there is a single row of columns, spaced 25 ft. longitudinally. The columns have bracketed tops wide enough to carry two lines of plate girder stringers 5 ft. apart and they support transverse plate girders which extend the full width of the building and carry the stringers for the tracks, platforms and roof columns. These girders have double webs, embracing the columns, thus making a very rigid floor system. At the east side of the line of columns on the south curb of Washington St. it was necessary to provide room for a driveway under the first pair of tracks, so that these could not be supported directly by columns.

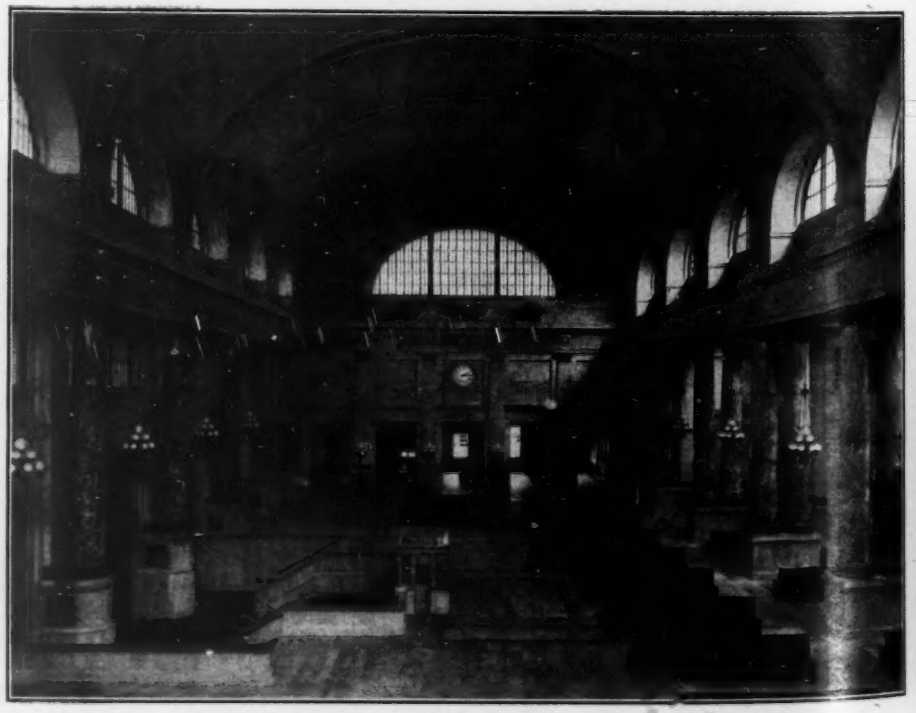

FIG. 5. WAITING ROOM OF CHICAGO TERMINAL STATION; C. & N. W. RY.

Here the columns are set 33 ft. apart, and the track stringers are carried entirely by the transverse plate girders, as shown in the cross section (Fig. 7).

Platforms and Trainshed Floor.

The trainshed has a solid floor of concrete resting upon shelf angles on the girders and track stringers. This is covered with waterproofing and provided with ample drainage outlets so that the entire surface can be cleaned by flushing. The concrete for the track floor is about 16 ins. thick, giving sufficient mass to absorb vibration; for the platforms it is about 6 ins. thick. In each case there is a 2-in. surface of asphalt mastic upon the concrete, with a layer of burlap in the asphalt. This forms the waterproofing and wearing surface. The platforms are 16 ft. 9 ins. wide, with a slight fall from the center to each side, the edges being 8 ins. above the level of the rail heads.

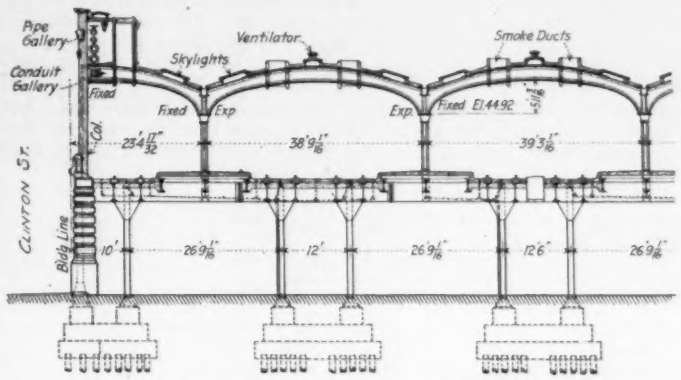

FIG. 6. PART CROSS SECTION OF TRAINSHED AND ITS SUBSTRUCTURE.

The application of the waterproofing was done under the supervision of the engineering department of the Standard Asphalt & Rubber Co. For the floor work, the specifications provided that on the clean and dry surface of the concrete there should be applied by brushes an asphalt primer coat (thin enough to penetrate the concrete) to ensure the close adhesion of the main coating. When the primer coat was dry, the waterproofing was applied at about 450° F. and in this was laid open-mesh burlap in three layers, each well mopped with the hot asphalt. The three-ply waterproofing mat thus formed is anchored in a recess in the concrete side walls, and is secured to the wood track stringers with metal flashing strips. This waterproof seal construction along the stringers is designed to maintain a close connection at all temperatures and in spite of the vibration due to train movements. Upon this mat is a 1½-in. coat of mastic which is given a cement finish. For the platforms, a two-ply burlap and asphalt mat is used. The mastic surface was leveled to the required thickness by the use of wood spreaders and floats. The finished surface was sprinkled and rubbed with fine sharp sand, which was swept off while the material was still hot. The surface was then rubbed with Portland cement, sufficient pressure being applied to eliminate all voids and blow-holes and to give a dense and homogeneous finish to the surface.

Track Construction.

The track construction in the trainshed is of special and interesting design, and is shown in Fig. 9. The rails are of the 100-lb. Am. Soc. C. E. section, and are carried by longitudinals of Oregon fir, 7½ × 15½ ins., which are laid directly upon the top chords of the track stringers. Steel tie plates ½-in. thick and 8 × 8 ins. in size are spaced 2 ft. c. to c., or 15 to a 33-ft. rail length. At each plate the rail is fastened to the timber by two screw spikes. The rail joints are spliced with 26-in. bars of the Continuous type, ⅞-in. bolts being used, and each bar held by the heads of two screw spikes. At each track stringer, a trough is formed in the concrete floor to receive the longitudinal timber.

The timbers are attached to the stringer flanges by hook bolts about 3 ft. apart and the arrangement for setting these bolts and providing for their removal is similar to that designed by Mr. Armstrong for the Lake St. bridge carrying the elevated railway across the approach tracks, which was described in our issue of Dec. 9, 1909. Iron pockets are embedded in the top of the floor concrete, forming pockets which project beneath the stringer flanges. When the timber is in place and the nuts are screwed home, the pocket is filled with soft asphalt, and the same material is used also as a filler in the 1-in. hole for the ¾-in. bolts. When the waterproof floor is laid the space between the concrete and the timber is filled with asphalt, and the burlap is carried under the face of a light sheet iron angle let into the side of the timber. Soft asphalt is then filled in at the top, as shown.

Track Plan.

The two four-track lines approaching the terminal unite in a six-track approach to the station, and this in turn spreads out to 16 tracks in the trainshed. The tracks are arranged in pairs, alternating with the platforms, except that at each side there is a single track next to the wall. The spacing of the tracks is alternately 12 ft. and 26 ft. 9 ins., while the platforms are 38 ft. 9 ins. c. to c. At the northeast end are four short stub tracks for mail cars, and the platforms for these are served by four elevators connecting with the mail room below. On the northwest side there is a stub track at the power-house for cars delivering coal and removing ashes. All these stub tracks are reached by reverse movement from the station.

The longest station track is 1,235 ft., and will accommodate a train of 18 cars; the shortest is 780 ft., for 11 cars. The total length of station tracks is 14,330 ft., accommodating 200 cars. Two pair of diagonal tracks across the six-track approach, with double slip switches at all intersections provide connection for any one of the approach tracks with any one of the station tracks. These slips have No. 7 frogs, so as to give easy and safe passage. There are 82 switches, 4 lap switches, 39 double slip switches, and 6 track crossings. The station track plan is shown in Fig. 3, while Fig. 10 is a diagram plan (not to scale) of the track layout of the entire terminal with its approaches.

Signals and Interlocking.

All the block signals and interlocking are operated electrically, this including the control not only of the signals but also of the switches and movable-point frogs. The signals are of the three-position semaphore type, working in the upper right-hand quadrant; the signals governing high speed moves are mounted on signal bridges, while the low-speed signals are of the dwarf type. This latter type is used entirely for the terminal plant proper. Each dwarf signal has a large revolving white disk (instead of an arm); the disk has a red stripe representing a semaphore arm, and two holes for the lenses. This signal is more conspicuous than the ordinary small semaphore arm used for dwarf signals. For the high-speed signals there are 11 steel bridges (Fig. 10). The track circuit is operated from storage batteries, which are charged by means of motor-generator sets in the towers; current for this equipment is supplied from the power-house. The General Railway Signal Co. had the contract for all the signal and interlocking work.

There are five signal towers on the terminal system (see Fig. 10): (1) Lake St., at entrance to station; (2) Clinton St., at junction of north and west approaches; (3) Carpenter St., at entrance to Erie St. coach yard; (4) Division St., at connection of north approach with the Wisconsin Division; (5) Noble St., at connection of west approach with the Galena Division. The equipment of these towers is given in Table III. The switch levers have indicator lights to show when they

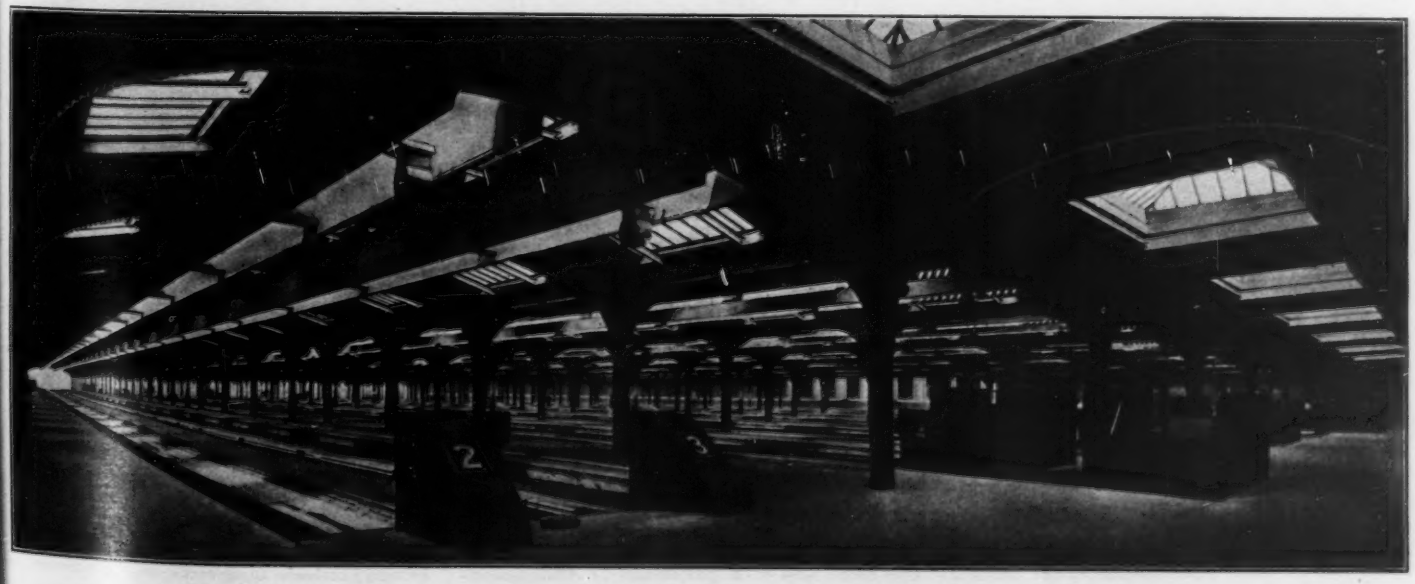

FIG. 7. INTERIOR OF TRAINSHED OF CHICAGO TERMINAL STATION; CHICAGO & NORTHWESTERN RY.

are unlocked, these lights being controlled by the detector circuits.

TABLE III.—LEVERS OF SIGNAL TOWERS ON THE NEW CHICAGO TERMINAL OF THE CHICAGO & NORTHWESTERN RY.

Levers.	Lake St.	Clinton St.	Carpenter St.	Division St.	Noble St.	Total
For signals	67	29	8	12	10	126
For dwarf signals ..	..	33	15	11	11	78
For switches ...	29	26	7	25	7	94
For double slip switches.....	46	12	8	6	8	80
For movable point frogs	23	6	4	..	4	40
For derails	..	35	13	17	11	36
To govern traffic	6	14	6	6	4	76
Working levers..	171	155	61	88	55	530
Spare spaces.....	37	13	15	32	25	122

Two of the tracks on the north approach are signaled for operation in both directions. The traffic on these tracks is reversed at noon and this the towermen and gatemen are advised by the conductor when the train will be ready to leave; the gateman and conductor are advised by the tower director when the train will be handled; and the conductor and tower director are advised by the gateman when the gate has been closed and train may leave.

In the main tower at Lake St. and also in the second tower at Clinton St., there is provided a large illuminated diagram on which is indicated the position of each train in each part of the yard or on the station tracks. This is so constructed that the moving of the train on the tracks into or out of the depot or within the limits of these interlocking plants is shown, so that the tower director may know even in stormy weather or at night the exact location of each train at all times.

aggregate length of about 1,200 ft. [illegible] equipment was built by the Stevens-Adam[illegible] Mfg Co. The belts are 26 ins. wide, and are [illegible] ins. below the floor level; their running speed [illegible]00 ft. per min., and this is attained in 10 secs [illegible]fter starting the motor. Each belt runs in a [illegible]el trough 36 ins. wide, covered by watertight, [illegible]oller-bearing cover plates, which are checked [illegible]d castings ⅜-in. thick. These extend the whole length of the trough, and when closed they are locked automatically and form a service walk between the tracks. The cover can be opened at any desired point.

When a mail train arrives, the mail sorting room of the post-office (beneath the train floor) is notified by a gong signal, and an indicator shows which conveyor is to be operated. The conveyor cover is opened at a point convenient

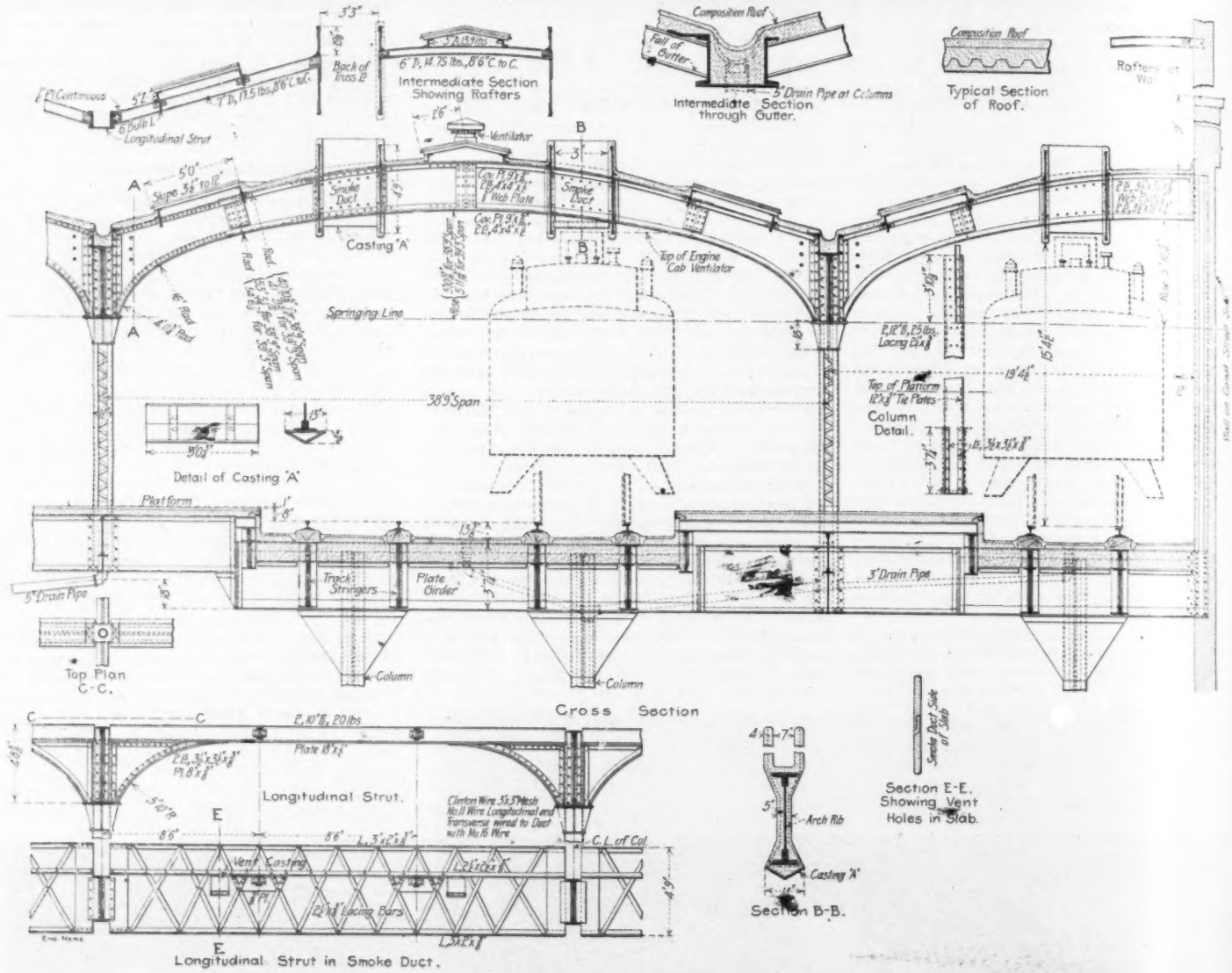

FIG. 8. DETAILS OF TRAINSHED.

midnight each day. This is done on account of the heavy suburban business, requiring a large number of empty coach trains going to the yard in the morning and being fed from the yard to the terminal station in the afternoon. In order that these may not have to cross through the inbound schedule trains at two places in the morning, the reversal of the traffic on these tracks was determined on as a very ready means of obviating this difficulty.

A system of using small electric lights as in telephone work is provided for rapid communication between the signalmen at the various towers. There is also a system provided for communication between train conductors on the platforms, the gatemen, the ticket inspectors and the tower director at the Lake St. signal tower. By

A special feature of the equipment is a system of snow melting provided in the terminal station yard so as to save the necessity of having to load and haul away the snow that may collect.

Conveyors and Elevators.

A specially interesting feature of the equipment is that conveyors are provided for handling the mail from incoming main-line trains and delivering it to the sub-post-office located in the station, without interfering with the traffic on the passenger platforms. At four of the pairs of tracks, electrically operated belt conveyors are placed in the space between the tracks, and in two of these cases there are two conveyors (placed in line with one another). The conveyors are from 148 ft. to 225 ft. in length, with an

to the mail car, and the sacks are thrown directly upon the belt, which delivers them to chutes leading to the sorting tables. There are also two platform elevators which deliver mail sacks to chutes at the rear ends of the conveyors, and the sacks from the elevators are thus conveyed to the sorting room by the conveyors.

The elevator system includes 14 high-pressure hydraulic elevators and 10 electric elevators; of the hydraulic elevators, 7 are for baggage, 5 for passenger service and 2 for special service; of the electric elevators, 8 are for baggage, express and mail, and 2 for mail only. A pneumatic tube system connects the inbound and outbound baggage rooms, to provide for the transfer of tickets, baggage, checks, etc. This system has

an elliptical tube 3 × 6 ins., with carriers 9 ins. long.

Power Plant.

The power-house is located conveniently in the triangular block at the north end of the station. At one side of it is a short stub track for cars delivering coal, the same cars taking ashes from an overhead bin. The cars discharge the coal into a track hopper of 400 tons capacity (and long enough for two cars to be unloaded at

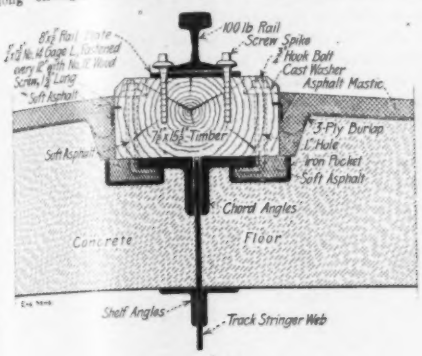

Fig. 9. Track and Floor Construction of Trainshed.

once); a conveyor then delivers the coal to a crusher, from which it is discharged upon a bucket elevating conveyor which serves an overhead coal bunker of 750 tons capacity. This conveyor plant is capable of handling 40 tons per hour. The coal conveyor also serves the ashpits, and delivers the ashes to an inclined conveyor discharging into a storage bin of 100 tons capacity. Under the sidewalk, and on a level with the boiler room floor is an auxiliary coal bunker of 300 tons capacity.

There are six water tube boilers of 500 HP. each, arranged in battery. They are built for 200 lbs. working pressure and are equipped with superheaters and traveling chain gates. An exhaust steam turbine driving a 500-KW. 230-volt D. C. generator is installed, space being left for a future unit of the same size. This turbine is connected to the main exhaust line and utilizes exhaust steam from the cross-compound, non-condensing engines. The heating system is also connected to this exhaust main, live steam being fed into the exhaust line through pressure reducing valves to make up whatever additional steam is required for heating or for the exhaust steam turbine, provided sufficient exhaust steam is not given by the engines. The exhaust steam turbine is connected to a surface condenser. With the condenser, motor driven centrifugal pumps are installed to care for the circulating water and condensation. The circulating water is discharged into a cooling tower which is located on the roof of the power-house. This combined system of exhaust steam turbine and non-condensing engines forms a very economical arrangement.

The smokestack is of radial brick construction, with an inside diameter of 11 ft. and 10½ ft. at base and top respectively; its top is 245 ft. above the boiler room floor or 227 ft. above the street. Its lightning protection consists of four points (with 24-in. platinum tips) and two ⅞-in. stranded copper conductors with copper ground plates and lightning indicator device.

There are three vertical cross compound Corliss engines of 1,150 HP., each connected directly to a 750-KW. generator; also a low-pressure steam turbine with 500-KW. generator. Space is provided for an additional engine-driven unit and turbine driven unit. Supplementary to this 250-volt direct current generating plant are two 500-KW. motor-generator sets for converting the 220-volt direct current to 6,600-volt three-phase 60-cycle current for subway lighting, signals, and yard service. The motors installed at the power-house and throughout the station aggregate about 780 HP. The plant includes also two two-stage cross-compound air compressors, each with a capacity required to compress 500 cu. ft. per min. to 100 lbs. pressure. The compressed air is used for charging the air-brake reservoirs on trains.

In the boiler room in the main building, there is installed a garbage destructor, manufactured by the Morse-Boulger Destructor Co. This has a flue which connects directly with the stack, carrying off all the noxious and disagreeable odors caused by the combustion of refuse. The destructor is 14 × 6 ft., and 6 ft. high; it has a capacity of destroying four tons of miscellaneous garbage and refuse in 24 hours.

All lighting in the building, trainshed and yard is by tungsten incandescent lamps (with globes or shades); no arc lamps are used. In the post-office sub-station there are a number of Cooper-Hewitt mercury lamps. For the indirect lighting in the main waiting room the lamps are arranged behind suitable screens on the north and south cornices or ledges. City water is used for domestic service. The ventilation of the building is effected mainly by air discharged into the rooms by fans; this can be heated in winter to maintain an average temperature of 70° F., and in summer it can be cooled to 6 or 8° below outside temperature.

Approaches.

The station is approached by two separate divisions, as already noted. The approaches to the old Kinzie St. station were at the street level for some distance, but at about a mile from the station the track elevation work commenced. The new station necessarily had its tracks elevated, and in designing the new approaches it was decided to build these independently, partly to give better access to the station and partly to avoid the interruption to traffic due to elevating and widening the old approaches under heavy traffic. Each approach therefore swings off from the old line, and then runs parallel with (but at some distance from) the latter. These new approaches were described in our issue of Oct. 18, 1906.

These elevated approaches consist of solid filling between concrete retaining walls and abutments; with solid-floor steel bridges over the streets. From the junction with the six-track approach or throat at the entrance of the station, one four-track approach extends north to connect with the Wisconsin Division at Division St. (1.3 miles), and another extends west to connect with the Galena Division at Noble St. (1 mile). The tracks are about 18 ft. above the street level. The concrete walls are of gravity section, built in sections upon a continuous concrete base supported on piles. They are of gravel concrete (1:2:5) with pieces of steel rails to connect or bond adjacent sections and with steel rails as reinforcement in the base. The maximum height of wall is about 25 ft.

The bridges are mainly of the self-supporting trough-deck system with ballasted floors, as used on other track elevation work on this railway and described in our issue of Sept. 7, 1905. The trough spans are supported by cross girders on columns at the curb line and also (in some cases) in the middle of the street. For long spans or skew crossings through plate girder spans were used, having a solid floor of transverse I-beams.

In both cases the troughs (longitudinal or transverse) are filled with concrete, this being a wet mixture of 1:2:4 proportions. This extends above the troughs so as to form a continuous sheet of concrete, and upon this is the waterproofing layer. This waterproofing is very important, in order to avoid complaints from water dripping in the subways. The method adopted was similar to that employed for the trainshed floor, described above. After the concrete had set thoroughly, it was first cleaned and then covered with a binding concrete to fill the voids and make a dense surface. When this was dry, a heavy coat of hot asphaltic composition was applied with mops and 40-in. strips of burlap were laid in this and well mopped with asphalt. There were four coats of the composition and three layers of burlap, the joints of the latter being so as to form a continuous sheet covering the entire width and length of the floor. The surface was then finished with two ¾-in. layers of hot sand-mastic, composed of 1 part asphaltic composition and 4 parts clean sand.

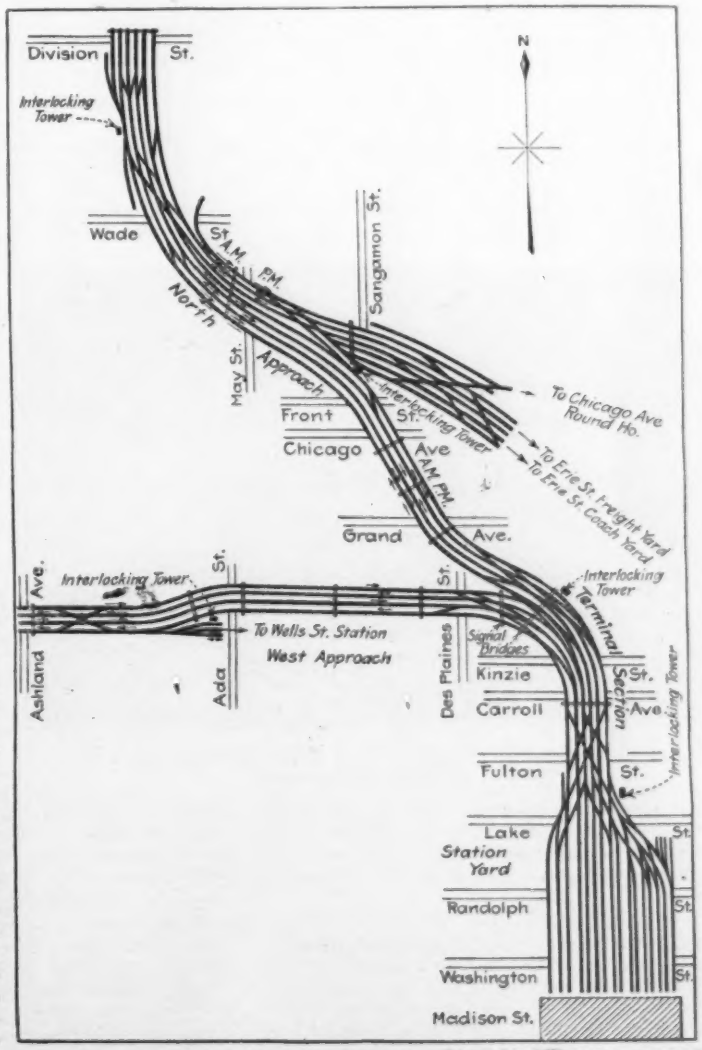

FIG. 10. GENERAL PLAN OF TERMINAL AND APPROACHES, SHOWING THE ARRANGEMENT OF TRACKS AND THE LOCATION OF SIGNAL TOWERS AND BRIDGES.
(Not to Scale.)

A Prepared Filler for Macadam Roads.

By CHARLES H. HOYT, C. E.*

Previous to the use of the method of applying bituminous binders during the construction of macadam roads, as described herein, there were two general methods of application used in this country—generally known as the "penetration" and the "mixing" methods. This new scheme the author has called the "prepared-filler" method. The mixing method, while admittedly the more thorough of the two, has been considered too expensive to be adopted generally in highway construction. The penetration method has had the advantage of being more convenient by requiring less outfit for its application, faster in its manipulation, and also somewhat cheaper in first cost. This method, while much used, has, however, not been altogether satisfactory.

FIG. 1. MIXING PREPARED FILLER FOR MACADAM ROADS.

The method of constructing bituminous macadam by the use of a prepared filler is new in this country. It combines practical convenience in manipulation with thorough construction, and falls between the other two methods referred to in first cost. In fact, it can be built for very nearly the same cost as the penetration method.

The ordinary "water-bound" macadam served its purpose for many years—until traffic conditions changed and became more severe, thus requiring a more tenacious road surface to resist the forces that come upon it. In the destruction of a water-bound macadam surface by the rapidly moving vehicles and hoofs, the larger stone are not removed first, but the screenings and smaller material are pulled or pushed out of place, leaving the larger stone loose, which results in a rough and ravelled patch, which grows in size.

The prepared-filler method seeks to remedy this condition by coating this fine material, which has heretofore been disturbed, with a bituminous binder, before it is placed in the road around the larger stone. In this way the larger stone are bound and held in a matrix which is difficult to remove.

The actual construction is carried out very much the same as if plain water-bound macadam were being built. That is, the foundation course is exactly the same as for a plain macadam; then the top-course stone, varying in sizes from ¾ to 2 ins., is spread evenly to a depth of 3 or 4 ins., as may be specified for the depth of the top-course stone while loose.

The next step, taken while the top-course stone is still loose, is to apply a layer of prepared filler spread evenly over the top stone to a thickness equal to about 0.4 to 0.5 the depth of the layer of loose top course.

The prepared filler is made in the following way: To one volume of stone chips, or pea gravel, varying in sizes from ⅛ to ¾-in., is added about 40%, by volume, of clean sharp sand, and from 10 to 15%, by volume, (of stone chips or gravel only) of bituminous binder, which may be of any kind or quality that would be used by the penetration or mixing methods, although it would probably be of no advantage to use by this method the lightest grades of those binders that are specified for the penetration method.

The stone chips (or pea gravel), sand and bituminous binder are heated, or not, as may be required to secure a uniform mixture. Then they are thoroughly mixed together either on a board with shovels or in a machine mixer.

After the layer of prepared filler has been spread over the top course of stone, it is then worked down into that course by rakes, or by harrowing with a light steel spike-toothed harrow whose teeth are about ½-in. square, set close together and about 3 ins. long. The harrowing should continue only until the top-course stone begins to appear generally throughout the layer of the prepared filler. Then the surface is rolled with a 10-ton roller until it is firm.

More of the prepared filler may be sprinkled over the surface to cover bare spots which develop as the rolling progresses. If desired, after the first rolling has been finished, a surface coat of the prepared filler, about ¾-in. in thickness, may be applied and the surface re-rolled.

Two sections of road—one 50 ft. long, the other 75 ft. long and 16 ft. wide—were built by this method, under the supervision of the writer, last September at Ithaca, N. Y., on East Ave., passing Cornell University campus. On the 50-ft. section, after the first rolling had been finished, a paint coat of about ½-gal. per sq. yd. of oil asphalt was applied and covered with stone chips. On the 75-ft. section a surface coat about ¾-in. thick of the prepared filler was applied, as described above. An oil-asphalt binder was used for the 50-ft. section and a "cut-back" oil asphalt was used for the 75-ft. section. Typical views of various stages of the work are shown in the accompanying figures.

FIG. 2. PREPARED FILLER SPREAD OVER TOP-COURSE STONE; BEFORE HARROWING.

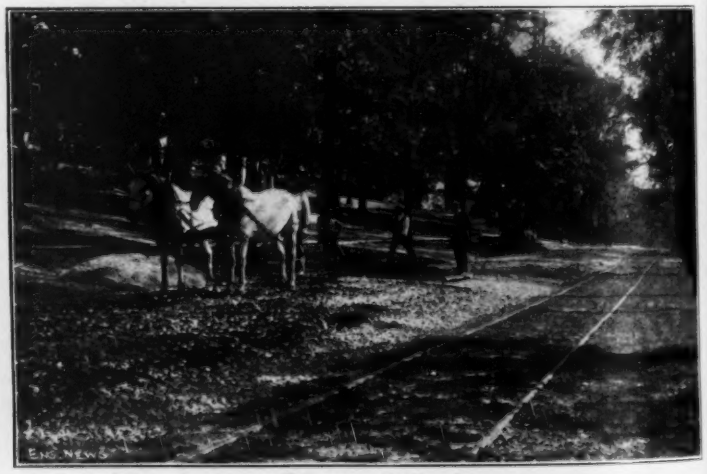

FIG. 3. SPREADING AND HARROWING PREPARED FILLER.

Reports from this roadway show that both sections are in good condition. The 75-ft. section, which had more of the prepared filler applied and had also a ¾-in. wearing surface of prepared filler, is showing up much better than the 50-ft. section which had a smaller amount of filler in the top course and had also only a paint coat of bitumen on the top. This is in accord with the writer's expectations. In fact, the whole idea of the scheme was to get rid of applying the bitumen from hods, sprays, or like appliances, either as a paint or a first coat.

The writer believes that this method has very strong features in its favor as a practical method of building bituminous-bound macadam. No ruts appear in the sections built at Ithaca and there is no evidence of water having collected between the bituminous-bound and bottom courses of stone.

Before the Ithaca strips were built, there was considerable doubt about being able to harrow the material into the top-course stone. It was thought by some that it would be necessary to make the filler of such lean proportions that it would not form a strong enough matrix. These predictions have not come true. In fact, on the 50-ft. section, which was the first one built, the material was harrowed in too deep—which may account for that section not showing up as well as the 75-ft. one which was harrowed much less.

The bitumen can be mixed with the stone chips and sand much more uniformly than when applied by any penetration-method apparatus which the writer has yet seen. The amount of bitumen to a square yard of road can be controlled perfectly by using more or less sand. The more sand used the more pliable is the prepared-filler mixture.

By using the proportions of materials stated for the prepared filler—that is, one volume of the stone chips or gravel, 40% of sand, and 10% of bituminous binder—a layer 1 in. thick over 1 sq. yd. requires the following amount of material:

0.028 cu. yd. of chips;
0.0112 cu. yd. of sand;
0.0028 cu. yd. of bitumen,
or 0.567 gal. per sq. yd.

If 15% of bitumen is used, then 0.85-gal. per sq. yd. is required. Assuming that a layer of the prepared filler, 2 ins. in depth, is used, the 10% filler will require 1.134 gals. of bitumen per square yard of road surface, and the 15% filler will require 1.7 gals.

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The sand has a two-fold purpose, (1) to fill a part of the voids, and (2) which is the principal reason for its use, to control the consistency of the mixture so that it can be manipulated freely. The amount of sand required can be determined by a few trials and will vary with the kind and amount of binder used.

It is better to harrow or rake the prepared filler into the top course as soon after the filler is spread as possible. However, no difficulty was experienced in harrowing in some that had laid two hours after it was spread.

Some advantages of this method are:

(1) The amount of stone that is required to be heated is about one-half or less, the amount required to be heated for the mixing method, thus reducing cost and saving time over the all-mixing method.

(2) The amount of bitumen required is less than by the penetration method. The amount used can be well controlled and but very little wasted.

FIG. 4. ROLLING MACADAM ROAD AFTER HARROWING PREPARED FILLER INTO TOP COURSE.

FIG. 5. A PREPARED-FILLER MACADAM ROAD IN VARIOUS STAGES OF CONSTRUCTION.

Foreground—Harrowed and rolled. Middle ground—Surface coat in place. Background—Finished surface.

(3) The prepared filler can be applied evenly, and when worked into the top course it fills the voids and thus makes the surface comparatively solid and durable.

(4) The manipulation of the prepared filler is rapid and convenient. The heating and mixing can all be done at one place, such as at the crusher site, and the prepared filler hauled to the road where it is to be applied.

(5) The prepared filler can be spread practically as well as dry screenings. Thus it is an economical and practical method of applying the bituminous binder, and gives a solid and substantial road.

Dynamometer Tests on Broad and Narrow Tired Wagons and on Plows.

By WM. CLYDE WILLARD.*

During April and May, 1911, a series of dynamometer tests to determine the relative tractive resistance of broad and narrow tired wagons was conducted under the direction of the writer at the State College of Washington. In conjunction therewith, tractive-resistance tests were made on two plows.

In making the tests a "Pattern B" Schaeffer & Budenberg recording dynamometer registering to 4,000 lbs. was used. In this instrument the paper record slip was fastened on a drum 4 ins. in diameter making one revolution per hour.

The results in pounds were obtained by planimetric averaging from the record slips. The area enclosed by the dynamometer autograph, the zero line and the ordinate at beginning and end of run, was measured by a rolling planimeter. This area was divided by the length of the zero line to give average pull. Some difficulty was encountered owing to the fact that the clockwork which revolved the drum of the dynamometer ran so slowly that the lines made by the pencil overlapped each other to such an extent that it was impossible to trace out each separate line. To overcome this the lines joining the points of maximum and minimum pull were traced by the planimeter and the mean of the two areas taken as the result. This probably gave as accurate a result as could have been obtained had it been possible to trace each pencil line throughout its entire length.

TESTS ON WAGONS.—Eleven tests were made, each test consisting of a run of the wide tired wagon (tire 4 ins. in width) and the narrow tired wagon (tire 2 ins. in width), similarly loaded, over the same ground. A study of the records made brought out the following facts common to both widths of tire:

Irregularity of Traction.

1. On macadam in good condition the tractive resistance varied continuously within a range of about 200 lbs.

2. On a good earth road covered with a sprinkling of small (2-in.) loose stones, up a grade where the average pull was about 800 lbs., the resistance varied over a range of 600-800 lbs.

3. On blue-grass sod the resistance varied over a range of 400-600 lbs.

4. On level, smooth roads where the tractive resistance was low, the force required to start the load was from two to three times the average force required to draw the load at the speed of a walk.

5. On grades where the resistance was high, the force required to start the load was about the same as the maximum limit of the range in the force required to draw the load up the grade at the speed of a walk.

TABLE I.—TRACTIVE RESISTANCE OF PLOW IN STUBBLE LAND.

Test number.	Description.	Draft in pounds.
1	7-in cut, loose stubble land on about a 10% grade, man rode	900
2	Same as 1, except that man walked	883
3	All conditions the same as 1, except that the coulter was moved ½-in. toward the land side of the furrow and several bolts about the plow were tightened	776
4	Same as 3, except man walked. (The increase in draft was caused by the plow not scouring for a part of the distance.)	822
5	7½-in. cut, otherwise the same as 4	849

TABLE II.—TRACTIVE RESISTANCE OF PLOW IN CLOVED SOD.

Test number.	Description.	Draft in pounds.
6	6½-in. cut, heavy clover sod, almost level	949
7	6½-in. cut, thin clover sod, coulter ½-in. in furrow, furrow wheel ran free	850
8	Same cut and sod as 7, coulter ¼-in. outside of furrow, furrow wheel ¼-in. below land side	689
9	Same sod and cut as 7 and 8, coulter same as 8, furrow wheel ¾-in. below land side	697

From the results of the tests the following general conclusions were derived, injurious or beneficial effect on the road surface being disregarded and draft alone being considered:

Comparison of Wide and Narrow Tires.

1. On hard, comparatively smooth surfaces, such as macadam, or on an earth road with a sprinkling of small, loose stones on its surface, the advantage is with the narrow tire.

2. On all compressible surfaces, such as smooth earth roads, the advantage is with the broad tire.

3. On all farm land, such as meadow, plowed ground and stubble, the advantage is with the wide tire. (On stubble, however, where the land is rolling, as is a large part of the dry farming districts of the west, much trouble results from the skidding of broad tires.)

4. On surfaces where there is soft mud so that both broad and narrow tires must cut down to a firmer layer below, the advantage is with the narrow tire.

The above conclusions only verify the results of previous experiments conducted elsewhere.

TEST ON PLOWS.—In conjunction with the tests on wagons several tests were made to determine the tractive resistance of plows. The results should be of great interest to all users of plows or to those interested in farm mechanics. Two plows of diff réentcfumanauter chanics. Two plows of different manufacture were used. Test group A (Table I.) was made with a Parlin & Orendorf 14½-in. two-bottom gang plow; test group B (Table II.) was made with an Oliver chilled 14½-in. two-bottom gang plow. Each plow was drawn by six horses. The results are tabulated below.

In the tests reported in Table I., a change of ½-in. in the position of the couuiter made a difference in draft of 124 lbs., or a difference of almost one horse. Tests 1, 6 and 7 show the difference in resistance of the two sods and stubble. Tests 7, 8 and 9 show the change in draft made by a shift in the positions of the furrow wheel and coulter. Comparing 7 and 8 it is seen that shifting the position of the coulter ¾-in. and lowering the furrow wheel ¼-in. made a difference in draft of 161 lbs., or over one horse difference. Five horses could have pulled the plow easier after the shift than the six could before. The resistance is increased by having the furrow wheel too low, as shown in Test 9.

846 Tons of Dynamite in a Single Shipment.—The largest cargo of dynamite ever brought to the Isthmus on one vessel was unloaded from the Munson Line steamship "Alm," which arrived at dock No. 14, Cristobal, on June 27. The shipment consisted of 29,363 cases, the contents of which aggregated 1,691,191 pounds, equivalent to about 846 tons.—"Canal Record," July 5.

*Professor of Railway and Highway Engineering, State College of Washington, Pullman, Wash.

6-Ft. Gate Valves for the Chicago 9-Ft. Water Tunnel; and a Design for a 9-Ft. Valve.

The latest addition to the system of tunnels by which the water supply of Chicago is distributed to different parts of the city is what is known as the Southwest Land Tunnel, and an interesting feature of this is the use of 6-ft. gate valves to control the flow, the 9-ft. tunnel section being reduced to and enlarged from the 6-ft. gate opening by an arrangement corresponding to that of the Venturi meter.

The tunnel extends under 73d St. from a shore shaft (at Bond Ave.) to State St., and thence under State St. to 104th St., where it turns west to the new Roseland pumping station on Stewart Ave. Its length is 17,500 ft. to State St. and Southwest tunnel extensions built and contemplated.

At all the valve locations the tunnel is 8 ft. 8 ins. wide and 8 ft. 10 ins. high (of horseshoe section). The water will be under a head of about 100 ft., and will have a normal velocity of 2½ ft. per second or a volume of flow of 100,000,000 gals. per day. The design of valves to operate in and control the flow of so great a body of water in a tunnel of this size presented special difficulties. Tentative designs were made by one of the engineers and also by a manufacturing firm for valves serving openings 9 ft. diameter in the clear, the valve closing against a 9-ft. thimble or lining built into the tunnel. The engineering department, however, considered it inadvisable to use valves of this size. The principal reasons for this were the difficulty of operating such a large valve and the difficulty of making it tight, considering the conditions for the operating machinery. The plan finally adopted was to use 6-ft. valves, and to reduce the 9-ft. (approximate) tunnel section to a 6-ft. circular section at each valve.

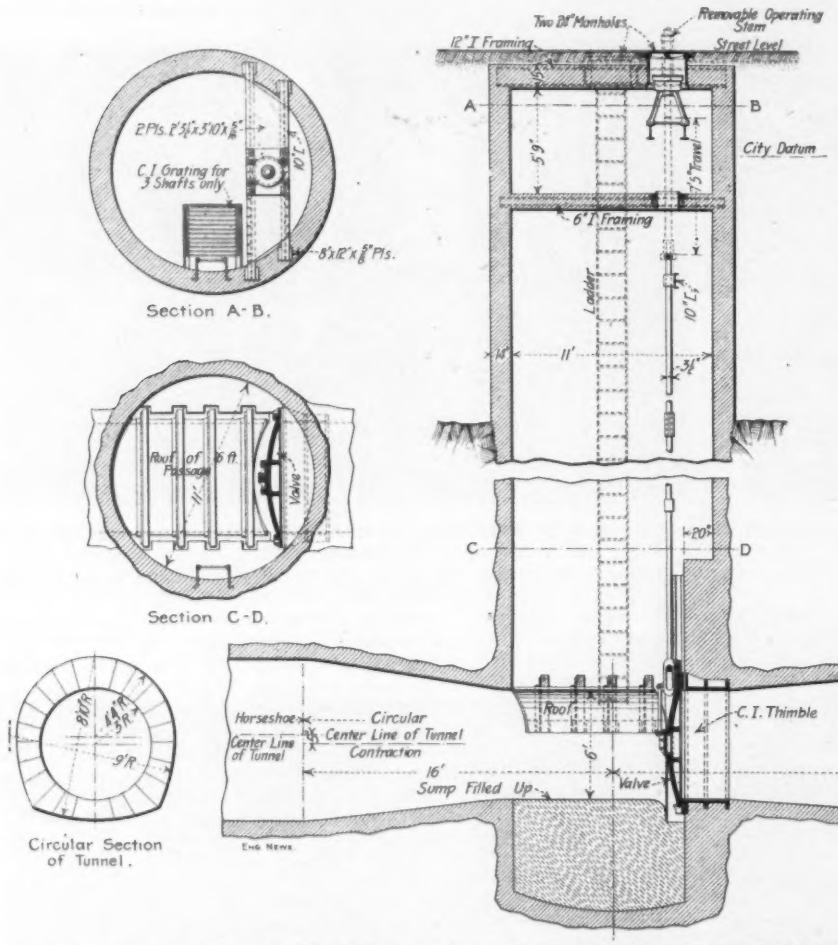


FIG. 1. ARRANGEMENT OF 6-FT. VALVE IN CONTRACTED SECTION OF 9-FT. WATER TUNNEL; CHICAGO WATER WORKS SYSTEM.
(John Ericson, M. Am. Soc. C. E., City Engineer.)

In order to avoid throttling or reducing the flow, the principle of the Venturi meter was adopted; the reduction (and change in form) is made gradually by a short taper section and the size is then increased again gradually by a longer taper section. In this way a uniform rate of flow is secured, the increased velocity and reduced volume at the 6-ft. throat compensating for the lower velocity and larger volume of flow in the normal tunnel section. The length of the 6-ft. circular section is 11 ft. 10 ins., including the thimble (2 ft. 6 ins. long) against which the valve closes. The length of the tapering section is about 10 ft. 6 ins. on the entering or receiving side, and 18 ft. 8 ins. on the discharge side. The center line of the entire contracted section (41 ft. long) is 5 ins. below that of the normal tunnel section, in order to compensate for the difference between the horseshoe and circular cross sections. This construction is shown in Fig. 1, which shows also the tunnel cross section and the general arrangement of the valve and its operating mechanism.

A difficulty in securing the proper action of the Venturi principle of uniform flow through a passage of reduced area (in which increased velocity compensates for reduced volume) is presented by the fact that this passage or throat occurs at an open shaft, in which water stands at an elevation of nearly 100 ft. above the tunnel. To overcome this difficulty it was necessary to fill up the sump to form the invert and sides of the throat, and to complete the throat artificially by placing a semi-circular shield extending across the shaft to form the roof of the contracted opening. The roof could not be made continuous, however, as an opening had to be left in it large enough to clear the valve and its operating rod or stem. Thus there will always be a body of still water in the shaft above the contracted tunnel opening, and in communication with the stream of water flowing through this opening. It is considered, however, that this will have little effect in reducing the rate of flow, owing to the relatively small area of the roof left open.

The roof is made removable to permit of future repair or removal of the valve, and also to permit of access to the tunnel for repairs or inspection. Its construction is shown in Fig. 2.

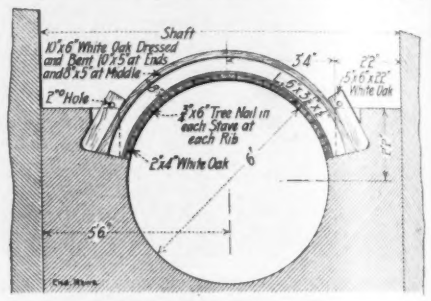


Fig. 2. Roof Over Contracted Section of Tunnel at Foot of Shaft.

The side walls of the 6-ft. throat (formed of concrete filling against the lining of the shaft) are made with a bench or seat for the roof ribs, and an undercut groove to receive wedging blocks which bear upon the upper faces of the ribs and thus hold the roof down against the upward pressure of the water (which pressure is balanced largely by the head of water in the shaft). The roof ribs are white oak timbers 10 × 6 ins., bent to shape, and each has a steel angle 6 × 3½ ins. bolted to one side. The lagging or roof lining consists of white oak staves 2 × 4 ins., fastened to each rib by a ¾ × 6-in. oak trenail.

THE 6-FT. VALVE.—The valve, shown in Fig. 3, is a convex disk about 6 ft. 6 ins. diameter, with a convexity of 8½ ins., and the disk is reinforced by horizontal and vertical ribs. The thickness of the metal is 2 ins. in the disk and ribs. At the upper end is an extension for the attachment of the operating rod, and at each side is an extension fitting within the guides. The face of the valve has a dovetailed annular groove to receive a ⅝-in. bronze

23,000 ft. thence to the pumping station, or nearly eight miles in all. It is to be connected to older tunnels at 68th St. and to other contemplated tunnels. It will be served directly by the Southwest Lake Tunnel, extending under Lake Michigan from the shore shaft to a new intake crib, a distance of about 11,370 ft. These tunnels were described in our issue of Nov. 14, 1907. They are all of horseshoe section; 14 ft. high and 13 ft. 8 ins. wide for the lake or intake tunnel; 12 ft. × 11 ft. 8 ins. to State St., and 8 ft. 10 ins. × 8 ft. 8 ins. for the balance of the land tunnel and its extensions. For emergency use in controlling or shutting off the flow in the tunnel branches four sluice valves will be provided. These will be placed at four of the working shafts which are retained as permanent valve shafts and are located as follows: (1) Oglesby Ave. (50 ft. north of 73d St.), (2) Yates Ave. (350 ft. south of 73d St.), (3) 73d St. and State St., (4) State St. (100 ft. south of 79th St.). The first named shaft will be on a branch tunnel forming connections with older parts of the water tunnel system; the others are on the

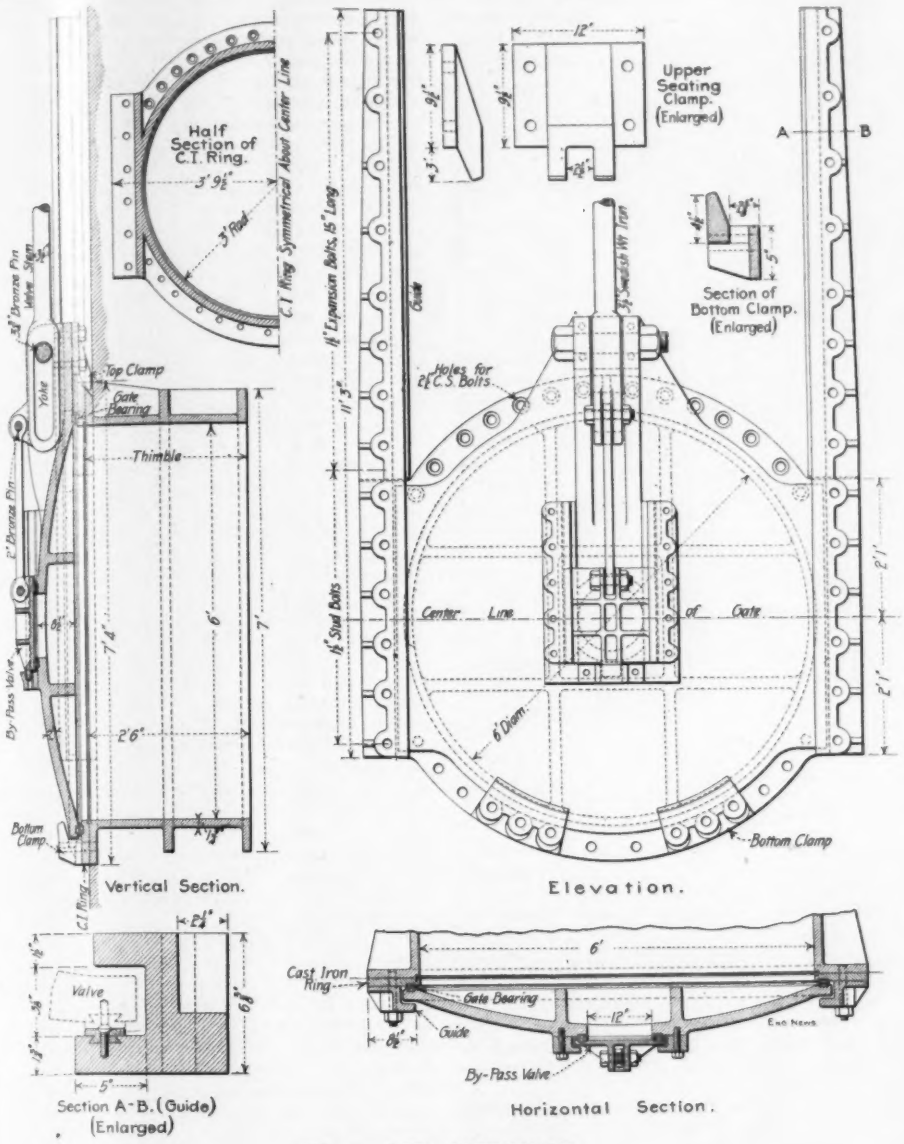


FIG. 3. 6-FT. GATE VALVE.

packing ring about 2 ins. wide; vertical packing strips are fitted to the two side extensions.

The valve closes against a cast-iron ring bolted to the flange of a 6-ft. thimble or lining which is embedded in the concrete of the throat and forms the discharge opening to the tunnel. The face of this ring has a bronze packing ring corresponding to that on the valve face. The contact faces of the cast-iron ring and thimble have grooves which form (when the parts are assembled) a dovetailed groove for a lead calking ring. When the valve closes it is forced against its seat (bringing the two bronze seat rings in contact) by means of three clamps. The top clamp is a wedge shaped lug fitting over an inclined seat on the back of the cast-iron ring, so that as the valve comes to the end of its travel it is pulled against the ring. The two bottom clamps are sockets with inclined faces to engage with the back of the disk so that the disk is pushed against its seat.

The by-pass is a 12-in. circular hole in the center of the valve disk, and this is fitted with a rectangular valve sliding vertically in guides on the back of the main valve. The by-pass valve has bronze seats, and in closing it is forced against the seat by means of a wedge-shaped lug fitting an aperture in a lug on the main valve. The by-pass valve is operated by a connection from the main valve stem, as is usual in valves of this class. In this design, the stem ends in a slotted yoke which engages the lifting pin on the valve. Attached to this yoke is the lifting rod of the by-pass valve. In opening the valve, the raising of the stem first raises the by-pass valve; by the time this is fully open the bottom of the yoke engages the lifting pin of the main valve and the latter is thus raised, after the tunnel has been filled through the by-pass. In closing, the main valve seats first, and the downward movement of the stem is continued until the by-pass valve also is seated.

The stem or lift rod is 3½ ins. diameter, and is made of Swedish iron, as this metal is not readily oxidized. The rod works in bronze-lined bearings attached to 10-in. channels extending across the shaft. The several lengths are connected by cast steel couplings and bronze keys. The head of the stem is provided with a large square nut which serves to hold the valve (when open) by resting on a removable support on the frame of the operating mechanism. This nut also forms the connection for the extension stem or operating rod.

OPERATING MECHANISM.—The valve is operated by a revolving nut on the threaded rod which forms the top section of the valve stem. As the shaft is in the street no permanent projection is permissible, and as the top of the shaft (at street grade) is only 4½ to 8½ ft. above water level there is little room for the machinery. Special means had to be devised therefore for placing and operating the mechanism, and as the valve will be operated only at very long intervals a removable working attachment was adopted. The general arrangement is shown in Fig. 1, while the details of the mechanism are shown in Fig. 4. At the head of the shaft is formed a chamber having a solid concrete floor and containing the operating mechanism, the top of which is within the manhole. The roof of the shaft has two 24-in. manholes, one over the operating machinery and valve stem and the other over the ladder which gives access to the tunnel.

The operating stem is 4½ ins. diameter over the thread, and has a square thread ¼ × ¼-in. of ½-in. pitch; on each side is a vertical keyway for a key which prevents the screw from turning in the nut.

The hoisting nut is of bronze and rides on a ball bearing consisting of 28 balls of hardened steel 1-in. diameter, which ride in a circular race formed by grooved rings of hardened steel. The lower race is carried by a pedestal casting resting on I-beams which extend across the shaft. When the valve is closed, the top of the threaded rod is just below the manhole cove: When it is required to operate the valve, the manhole cover is removed, and a turning piece consisting of a length of 6-in. steel pipe is placed; the lower end of this rests in a socket in the nut, to which it is secured by keys. The pipe carries a capstan head with holes for four oak capstan bars 7 ft. long. The nut being revolved in this way, the threaded rod is raised, lifting the valve. It is estimated that this can be done in one to two hours by four men. While the valve is open, the street is obstructed by the capstan and the threaded screw.

If the valve is to remain open, however, the threated operating stem can be detached from the head of the valve stem proper, and hoisted out (with the turning piece), so that the manhole may be closed. In that case, the valve is held open by placing a support under the large nut at the top of the 3½-in. hoisting stem. The valve can be held at any intermediate position by a hinged clamp whose interior face is threaded to fit the operating stem. This is closed around the stem and bolted up, and rests upon a cross brace in the pedestal which carries the operating mechanism. When the valve is in its normal position, the turning piece

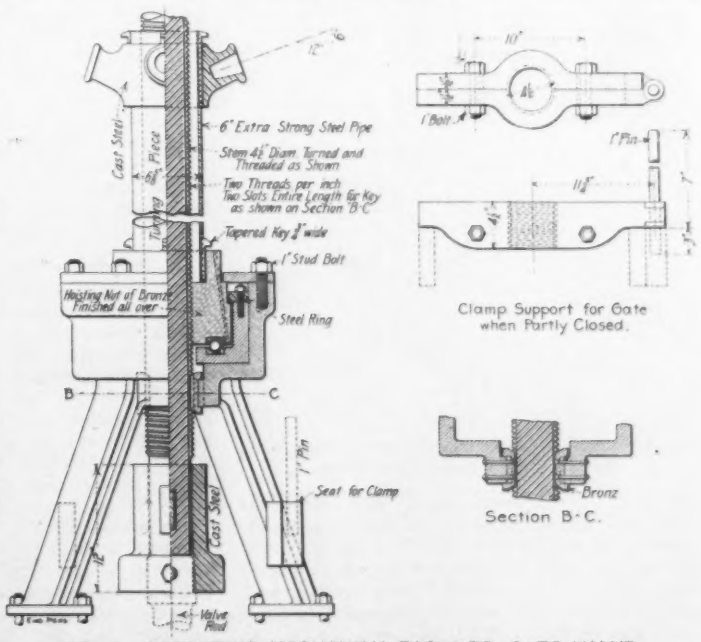


FIG. 4. OPERATING MECHANISM FOR 6-FT. GATE VALVE.

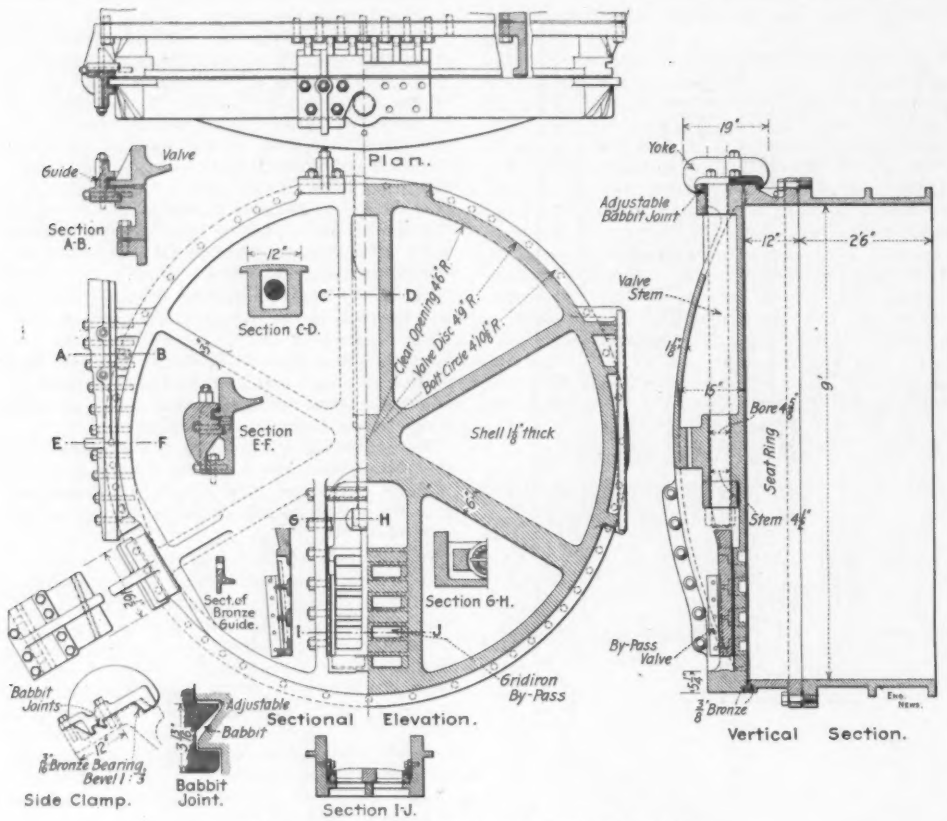


FIG. 5. DESIGN FOR A 9-FT. GATE VALVE.

is unshipped and stored in the chamber at the head of the shaft.

For the work on the tunnel alterations and installation of valves, the tunnel has to be pumped out and kept dry. The contractor is required to have at each of these shafts a pumping equipment capable of delivering at least 700 gals. per min. at the street level. The work at Oglesby Ave., however, involves the sinking of a new shaft and driving a short tunnel (about 60 ft.) to connect with the southwest tunnel at 73rd St. In the other direction from

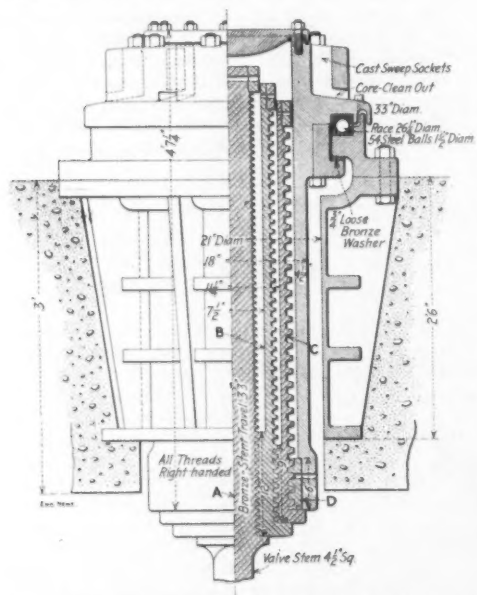


Fig. 6. Operating Mechanism (with Telescoping Screws) for a 9-ft. Gate Valve.

the shaft this branch tunnel will extend for about 200 ft., and at 30 ft. from its end it will be closed temporarily by a bulkhead 5½ ft. thick. This will be built of brick laid in cement mortar and having a 10-in. central space or core wall grouted with cement mortar. Through this bulkhead will be laid a 6-in. pipe with valve. At some later period this tunnel will be extended to connect with an old land tunnel at the 68th St. pumping station. The concrete for forming the contracted passages at the valves will be a 1⅛:3:5 mixture, made with 1-in. limestone. After the removal of the forms all projections will be trimmed off, and the surface covered with a plaster of cement mortar to fill all depressions and leave a smooth surface. This will be finished with a wash of neat cement applied with a brush, the final brushing being done horizontally so that all brush marks will be in line with the flow.

The valves and general construction described above were designed in the Department of Public Works, under the direction of Mr. John Ericson, M. Am. Soc. C. E., City Engineer of Chicago, and Mr. Karl L. Lehmann, Chief Designer. The contract for the valves and operating machinery was let in April, 1911, to the Coffin Valve Co., of Boston, Mass. The contract for the tunnel alterations, installing the valves and building the new shaft was also let in April to Gindele Brothers & Co., of Chicago.

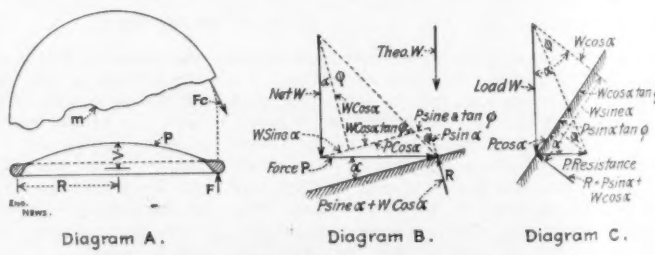


Fig. 7. Diagrams for Valve Design: (J. W. Pearl, M. Am. Soc. C. E.)

A Design for a Nine Foot Valve.

The reduction of the area of tunnel cross section is an undesirable feature, but was considered necessary in this case. However, designs are made for a valve to cover the full area of the normal 9-ft. tunnel cross section, as already noted. One of these presented interesting features, both in regard to the valve itself and to the operating mechanism, being designed to withstand a pressure of 50 lbs. per sq. in. acting upon either the back or the face of the valve.

The proposed valve, shown in Fig. 5, was to be about 9 ft. 6 ins. in diameter, with a convexity of 15 ins. The 6-ft. valve (Fig. 3) has a uniform thickness of 2 ins. In the 9-ft. valve, however, the metal in the disk or plate was to be only 1⅛ ins. thick, but the disk was to be retained by a heavy rim or flange about 5¼ × 9 ins. section to secure safety as a dished disk. Within the convex side were heavy ribs radiating to the clamps, and designed to relieve the rim when pressure was acting against the face of the valve. These ribs and the cast steel clamps (mentioned below) would be unnecessary with pressure always on the back of the valve, but were added to the design to make the valve safe in the event of water pressure being applied to the wrong side through misapprehension as to the valves and tunnel connections. Since the valves would be operated only at very long intervals, there might be liability of such misapprehension among the men in charge at the time.

The face was to have a bronze bearing, closing against a similar seat in the face of the valve ring, as described for the smaller valve. For closing, the valve was to be forced against its seat by three cast steel clamps, one at the top and the others at points 120° apart toward the bottom. The top clamp had an inclined face engaging with a similar face (fitted with a bronze plate) on the back of the cast-iron ring of the thimble. This clamp was to be attached to the rim of the valve by bolts in slotted holes and locked in position as adjusted by pouring a babbit-metal joint between the valve rim and clamp. The side clamps were of the same type; that is, they engaged the back of the valve ring, and so pulled the valve against its seat. In the 6-ft. valve, the edge of the disk fits into bottom sockets or clamps having inclined faces, so that the lower part of the valve is pushed against its seat, as described.

The by-pass was to be placed at the bottom of the valve (instead of at its center), and to be of the gridiron type. Its openings were inclined upward towards the discharge side, so that when discharging into the empty tunnel the water would not have a cutting or eroding effect upon the concrete. The main valve was to be operated by the by-pass valve, the latter being connected to the valve stem, with sufficient clearance to permit proper seating.

The operating mechanism was designed to occupy small space (on account of the conditions noted above), and would in no case involve any projection of the machinery above the street, as in the adopted type. In operating the valve, the manhole cover would be removed to permit of fitting bars or sweeps to the capstan head, but no other adjustment of working parts would be required, and the mechanism would sustain the valve in any position without the use of clamps, keys, or other locking devices.

The mechanism consists of three telescoping screws, with a nut, working in a cast iron sleeve or thimble embedded in a concrete floor near the top of the shaft. The arrangement is shown in Fig. 6. The center (solid) screw A, is an extension of the valve stem; its thread engages with a short interior thread (acting as a nut) on the sleeve B; the exterior thread on this sleeve is coarser, and meshes with a short interior thread (acting as a nut) on a second sleeve C; the exterior thread of the latter is still coarser and meshes with that of the operating nut D. This nut is formed in the lower end of a cast iron sleeve which has near the top a circular flange by means of which the weight of the nut is carried on a ball bearing. Above the flange is a capstan head with six slots for the vertical ends of iron sweeps 12 ft. long. After motion has been started by a gang of men a horse could be hitched to one of the sweeps to complete the movement of the valve. We are informed that

for the opening or closing of some of the existing 6-ft. valves in Chicago the labor of four men for four or five hours is sometimes required.

The particulars of the threads are given in the accompanying table, and in each case the nut thread corresponds to that of the sleeve or rod with which it meshes:

	Stem A.	Sleeve B.	Sleeve C.
Pitch of thread.....	¾-in.	1⅛ ins.	1½ ins.
Bevel of thread.....	1 in 4	1 in 4	1 in 4
Diam. over thread...	6 ins.	10½ ins.	14¼ ins.
Diam. at root.....5 $^{9}/_{16}$ ins.		9¾ ins.	12⅝ ins.
Diam. inside sleeve..		7½ ins.	11¼ ins.
Length .....4 ft. 3 ins.		3 ft. 11½ ins.	3 ft. 8 ins.
Travel .....3 ft. 3 ins.		3 ft. 2½ ins.	3 ft. 2 ins.
Height of nut..... (B) 1 ft.		(C) 9 ins.	(D) 6 ins.

In the illustration the mechanism is shown in its normal position with the valve raised, and the three threaded sections telescoped within the thimble. In this position the sleeves and nut can be filled with oil, which will be retained by leather gaskets below each nut, protecting all parts from rust and keeping them in lubricated condition ready for action.

The valve stem was to be 4½ ins. diameter, of cold-rolled steel, with screw sleeve joints. It would be supported at intervals of about 18 ft. by bearings in concrete floors covering a part of the shaft, thus ensuring rigidity and permanence of alinement. The top floor would cover the entire shaft and have a manhole at the ladder.

The design in question was prepared by Mr. J. W. Pearl, M. Am. Soc. C. E., who was at the time an assistant engineer in the Department of Public Works, Chicago.

The Design of Dished Valves and Valve Operating Screws.

Some notes on the design of large valves were published in our issues of April 20 and May 11, 1911, and Mr. Pearl* has furnished us with the following notes as to his methods in calculating the dimensions of the valve disk and the screw threads of the operating rods employed in the 9-ft. valve described above:

VALVE (Diagram A).—Stresses in a Dished Disk or Segment of a Sphere, under Fluid Pressure:

Let R = radius of segment in inches.
" V = vers sine of segment in inches.
" P = pressure in pounds per square inch, normal to surface.

Then the stress at support per inch of rim or flange, $F = P R \div 2$.

The stress in disk at any point as m in pounds per lineal inch

$$= \frac{P}{4\,V}\,(R^2 + V^2).$$

The stress in rim, or flange, in pounds,

$$Fc = \frac{P\,R}{4\,V}\,(R^2 - V^2).$$

For Diam. $= 8\,V$. Stress in disk $= 1.0625\ P\,R$ and $Fc = 0.9375\ P\,R^2$.

OPERATING SCREW (Diagrams B, C).—The Screw or Inclined Plane, Friction Considered. (1) Relation between P = force applied, and W = weight raised (Diagram B):

Angle of inclination of plane = a.
Angle of friction = ϕ.
Theoretical weight lifted (**W**) friction neglected, $= P \div \tan a$.

From the diagram of stresses with friction considered we obtain $W \sin a + W \cos a \tan \phi + P \sin a \tan \phi = P \cos a$. Also, $W = P \tan [90° - (a + \phi)]$.

Hence, efficiency

$$= \frac{W}{\mathbf{W}} = \frac{\tan a}{\tan (a + \phi)}.$$

(2) Relation between W = load applied and P = resistance required (Diagram C):

Angle of inclination of plane = a.
Angle of friction = ϕ.
Theoretical resistance **P** = (friction neglected) $W \tan a$.

From the diagram of stresses with friction considered we have $W \sin a - W \cos a \tan \phi = P \cos a + P \sin a \tan \phi$.

Also $P = W \tan (a - \phi)$.

Hence, efficiency,

$$= \frac{P}{\mathbf{P}} = \frac{\tan (a - \phi)}{\tan a}.$$

*3300 South Park Ave., Chicago.

The Urban and Rural Population of the United States.

The urban and rural population of the United States is the subject of a preliminary statement just issued by the Bureau of the Census. The urban population includes every one residing in cities and other incorporated places of 2,500 inhabitants or more and, in addition, the people residing in all "towns" of New England, whether incorporated or not. The comparative figures for the last three censuses are shown by Table I.

There were 14 states which in 1910 had more than half their population residing in urban territory. The respective percentages include the corresponding figures for 1900 and 1890, as well as for 1910, are as given in Table II.

A further table (III.) of considerable interest exhibits the distribution of urban population of 1910 by numbers of places of different sizes and total population in each of these classes, in addition to which percentages are given for the last three censuses.

TABLE I.—URBAN AND RURAL POPULATION IN THE UNITED STATES FOR THE LAST THREE CENSUSES.

Population.	1910.	1900.	1890.
	Number.		
Total	91,972,266	75,994,575	62,947,714
Urban	42,623,383	30,780,875	22,708,430
Rural	49,348,883	45,213,700	40,239,284
	Per cent. distribution.		
Total	100.0	100.0	100.0
Urban	46.3	40.5	36.1
Rural	53.7	59.5	63.9

TABLE II.—PERCENTAGES OF URBAN AND RURAL POPULATION IN THE UNITED STATES IN 1910 FOR 14 STATES IN WHICH MORE THAN HALF OF THE POPULATION WAS URBAN.

	1910.	1900.	1890.
Rhode Island	96.7	95.1	94.5
Massachusetts	92.8	91.5	89.5
Connecticut	89.7	87.2	83.5
New York	78.8	72.9	64.9
New Jersey	75.2	70.6	60.7
California	61.8	52.4	48.6
Illinois	61.7	53.9	44.5
Pennsylvania	60.4	54.7	48.6
New Hampshire	59.2	55.0	51.1
Ohio	55.9	48.1	41.0
Washington	53.0	40.8	36.6
Maine	51.4	48.6	45.2
Maryland	50.8	49.8	47.6
Colorado	50.7	48.3	45.0

It should be understood that the figures presented give the population as it existed at each census.

To show the rate of growth of the two classes of population, the territory and the population in either class in 1910 are used as the basis. Bearing this in mind, Table IV. may be studied with interest and possible profit by many of our readers.

Any one who is interested in further details of the growth of population can doubtless obtain a copy of the advance statement, and later on of the final report on the subject, by addressing the Bureau of the Census, Washington, D. C.

Four Sewage Pumping Stations have been installed in Grand Rapids, Mich., to handle the entire sewage of the city during flood stages of the Grand River, into which all the sewers empty. The normal flow of the river is such that it can be forded at any place, but during flood periods, which occur most often in the spring, the river rises 15 to 20 ft. in a few hours. The small drop between Grand Rapids and the lake allows this water to back up and flow into the sewers, thus causing serious damage in the basements in the downtown section of the city. To prevent the constant recurrence of this damage the river has been dredged and enclosed between concrete walls 20 ft. in height. The water is prevented from entering the sewer outlets by special valves. During normal flow of the river the sewage is discharged into the river as before, but at flood periods the sewage is discharged into a sump pit, from which it is pumped over the wall by centrifugal pumps.

Four pumping stations are required for the four sewer outlets. One station is equipped with two 18-in. centrifugal pumps operating under a normal head of 3.1 ft., with a capacity of 12,000 gals. per min., driven by 30-HP. electric motors direct connected. Two stations are equipped with two 24-in. and one 12-in. centrifugal pumps each, with a capacity of 17,000 gals. per min., driven by 60-HP. motors direct connected. The fourth station, which is at the terminus of the east side trunk sewer, has four 40-in. centrifugal pumps operating under a normal head of 6.7 ft., with a capacity of 47,000 gals. per min. These pumps are driven by 175-HP. motors direct connected. Each station is also equipped with a priming pump belted to their driving motors. The power is supplied by the Grand Rapids Muskegon Power Co. No attendance is needed at the stations except during flood stages of the river, when an attendant goes to the station, throws the main line switch and closes the valve on the sewer outlet. The sewage then flows through a by-pass into the sump pit. When the water here reaches a fixed level the operator starts the pumps and runs them as long as necessary. Two men are assigned to each station. The pumps were installed by the Buffalo Steam Pump Co., and the electric motors and equipment by the Westinghouse Electric & Manufacturing Co.

TABLE III.—NUMBER OF PLACES AND CORRESPONDING TOTAL POPULATIONS IN 1910, IN CLASSIFIED GROUPS, WITH CORRESPONDING PERCENTAGES FOR 1910 AND SIMILAR PERCENTAGES FOR 1900 AND 1890.

Class of Places.	Number of places, 1910	Population, 1910.	Per cent. of total population. 1910.	1900.	1890.
Total population	.....	91,972,266	100.0	100.0	100.0
Urban territory	2,405	42,623,383	46.3	40.5	36.1
Places of—					
1,000,000 or more.....	3	8,501,174	9.2	8.5	5.8
500,000 to 1,000,000.....	5	3,010,667	3.3	2.2	1.3
250,000 to 500,000.....	11	3,949,839	4.3	3.8	3.9
100,000 to 250,000.....	31	4,840458	5.3	4.3	4.4
50,000 to 100,000.....	59	4,178,915	4.5	3.6	3.2
25,000 to 50,000.....	120	4,062,763	4.4	3.7	3.7
10,000 to 25,000.....	374	5,609,208	6.1	5.8	5.5
5,000 to 10,000.....	629	4,364,703	4.7	4.3	4.0
2,500 to 5,000.....	1,173	4,105,656	4.5	4.4	4.3
Rural territory.....	.....	49,348,883	53.7	59.5	63.9

TABLE IV.—RATE OF GROWTH OF URBAN AND RURAL POPULATION BY CLASSES OF CITIES IN 1900-1910.

Class of Places.	Number of places in 1910.	Aggregate population in 1910.	1900.	Increase, 1900-1910. Number.	Per cent.
Continental United States.....	.....	91,972,266	75,944,575	15,977,691	21.0
Places of—					
2,500 or more in 1910.....	2,405	42,623,383	31,587,542	11,035,841	34.9
1,000,000 or more in 1910.....	3	8,501,174	6,429,474	2,071,700	32.2
500,000 to 1,000,000 in 1910.....	5	3,010,667	2,501,226	509,441	20.4
250,000 to 500,000 in 1910.....	11	3,949,839	2,930,263	1,019,586	34.8
100,000 to 250,000 in 1910.....	31	4,840,458	3,421,042	1,419,416	41.5
50,000 to 100,000 in 1910.....	59	4,178,915	2,946,018	1,232,897	41.8
25,000 to 50,000 in 1910.....	120	4,062,763	3,028,007	1,034,756	34.2
10,000 to 25,000 in 1910.....	374	5,609,208	4,137,132	1,472,076	35.6
5,000 to 10,000 in 1910.....	629	4,364,703	3,194,278	1,170,425	36.6
2,500 to 5,000 in 1910.....	1,173	4,105,656	3,000,112	1,105,544	36.9
Remainder of country.....	.....	49,348,883	44,407,033	4,941,850	11.1

The Condition of the Steel of the Gillender Building; Final Report.

By MAXIMILIAN TOCH.*

On July 14, 1910, there appeared in Engineering News a preliminary report by the writer on the condition of the steel of the Gillender Building† from the first floor to the roof, and many engineers awaited with a great deal of interest the uncovering of the cantilever girders, the grillage beams and the distributing girders.

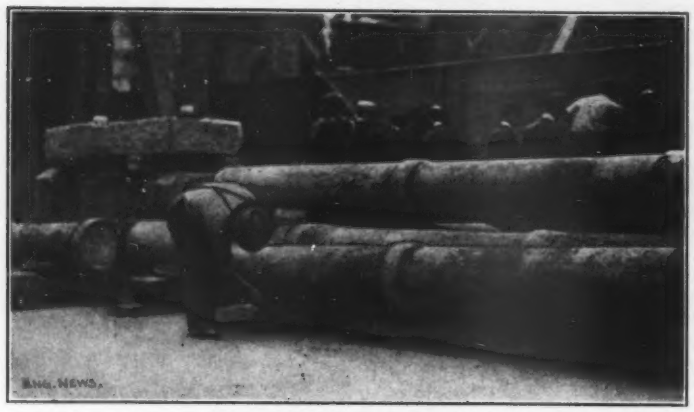


FIG. 1. STEEL PILES TAKEN OUT OF THE GROUND NEAR NORTHWEST CORNER OF OLD GILLENDER BLDG., NEW YORK CITY.
(Steel in excellent condition.)

Taking it all in all, the steel was in very good condition with one or two slight exceptions which are hardly sufficient to describe at any length. Figs. 1, 2 and 3 shows some specimens of the steelwork to illustrate. Fig. 1 shows steel piles taken out of the ground adjoining the northwest corner of the building; they were in a remarkably good condition. Fig. 2 shows a fairly clean condition of the columns, and only two rivets were found which showed any evidences of bad corrosion. These rivets are now in the possession of the author. Fig. 3 is a view taken about 15 ft. below the street level, and shows the oxyacetylene flame being used to cut the columns in two. These columns were absolutely devoid of any vestige of paint, for they were encased in a cement grout which had completely destroyed the linseed oil used as a binder.

The most interesting thing in the excavation relates to the condition of the column-footing grillages and girders. I am indebted to Mr. Harry Englander, a young engineer and a student of Columbia University at the time, who was on the field, for the sketch (Fig. 4) which shows the exact positions of the cantilever girders, the distributing girder and the 15-in. grillage beams. The grillage beams and the cantilever girders were in a remarkable state of preservation. Mr. Metzger, the superintendent for Marc Eidlitz & Son, called me on the telephone one day as they were uncovering these girders and told me to hurry down as the paint which they were exposing was still wet. I hastened down and found that the distributing girders had been encased in a cement grout which, upon analysis, showed itself to be a mixture of one part of cement and one part of fine sand. This came away from the steel perfectly clean, and the paint which adhered to the cement was apparently perfectly wet. I had, however, been prepared for this, and on making a determination at the place I found that what appeared to be fresh oil paint was an oil soap, without any trace of oil left excepting as calcium oleate, the balance of it being water. The erythrosine reaction showed immediately that the surface of the steel was perfectly wet because the water of the grout had never had an opportunity either to evaporate or to combine.

This is quite remarkable, but on mature deliberation it is quite natural, for at this tremendous pressure the excess of water in the concrete could not find any escape and remained "in situ" for all these years. The paint was still a bright red and was immediately pronounced red lead, but I gathered sufficient of it to take to my laboratory, and there found it contained over 42% of oxide of iron and no lead whatever, which again proves that under similar conditions oxide of iron is as perfect a protector as oxide of lead.

A careful examination of the cement grout showed it had completely set on its inner surface but had not set on its outer surface, and upon grinding it into a mortar and adding water to it, a briquette was formed which showed considerable tensile strength.

Fig. 2. A Column of the Gillender Bldg.
(Metal fairly clean; only two rivets showed bad corrosion.)

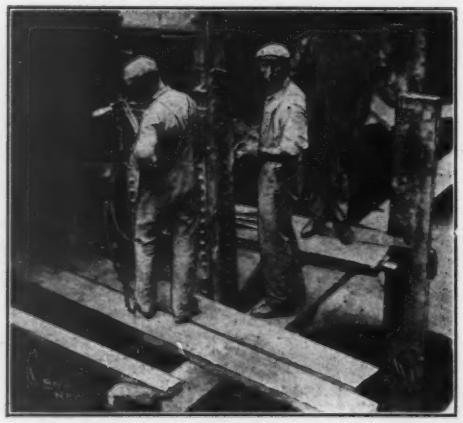


Fig. 3. Columns Below Street Level, Gillender Bldg.
(Metal bare of paint, the paint having been destroyed by the cement in which the columns were encased. Oxyacetylene lamp used for cutting steel apart.)

There was no trace of rust noticeable anywhere on the girders. There is a chemical law which says that "chemical reactions which produce pressure are retarded by pressure"; in other words, the formation of rust is accompanied by an increase of volume. If we put a pressure on the steel so as to prevent an increase of volume you cannot have any oxidation, and that is precisely what happened on the distributing girder and grillage beams: there was such a tremendous pressure on these beams that they could not rust under the circumstances.

On top of the distributing girder there was a thick layer of paving pitch, which was soft and pliable and showed a melting point of 98° F. This paving pitch was evidently a mixture of ordinary tar and hard pitch, and it was entirely displaced from the top of the girder owing to the pressure of the surrounding masonry. In fact, in no instance did I find any of it excepting on the lower flange of the distributing girder; the rest of it had oozed in various directions, but it was still soft and pliable and in excellent condition.

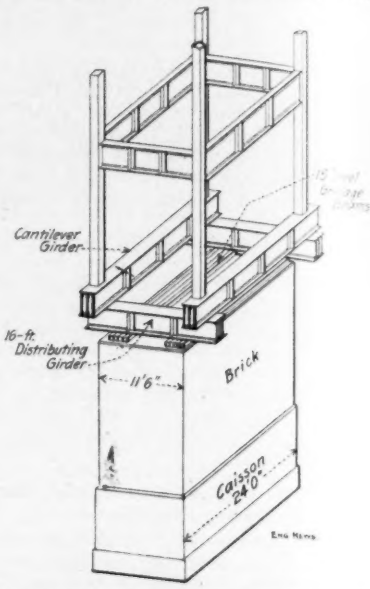


Fig. 4. Sketch of Arrangement of Caisson Grillage and Column-Supporting Girders, Gillender Bldg.
(Grillage beams and distributing girders excellently preserved. Iron oxide paint, which had been converted into oil soap by reaction with the cement and retention of water.)

The lessons that we have learned from the Gillender Building can be readily summed up in the following:

Steel ought never to be coated with a linseed-oil paint, but with a paint which is alkali-proof and which has insulating properties at the same time. If, however, an engineer insists on the use of a linseed-oil paint, the field coat or finishing coat should by all means be of a hydrocarbon nature and possess qualities which prevent it from being attacked by the alkaline concrete which is placed against it.

I am again glad to acknowledge the assistance I received from Mr. Metzger, Superintendent of Marc Eidlitz & Sons, who furnished me with many pieces of concrete, insulating covering, boltheads, etc.

*Municipal Lecturer on Paint, Corrosion and Concrete, at College of the City of New York; member of firm of Toch Bros., paint manufacturers, 320 Fifth Ave., New York City.

†Nassau and Wall Sts., New York City, 16 stories and 4-story tower, built 1896; demolished 1910, to make room for the larger Bankers' Trust Building.

Irrigation Statistics of the State of Washington.—The Bureau of the Census has issued the following statistics regarding the extent of irrigation in Washington. The total area under irrigation in 1909 was 334,378 acres, an increase of 146.8% over that in 1899. In 1910 the total irrigated area was 470,514 acres, with various projects under way to bring the total to 817,032 acres within a few years. In 1909 there were 156 reservoirs, having a capacity of 121,543 acre-feet, with 2,558 miles of main ditches for distributing the water. Of the total acreage in 1909, 55,690 acres, or 16.7%, were irrigated from works built by the U. S. Reclamation Service; 35,000 acres, or 10.5%, were irrigated under the U. S. Indian Service acts; by co-operative enterprises, 81,122 acres, or 24.3%; by enterprises supplying water for hire, 66,911 acres, or 20%; by private and partnership enterprises, 95,655 acres, or 28.6%. Streams supplied water for 310,426 acres, or 92.8%, lakes 10,782 acres, or 3.2%; springs 4,207 acres, or 1.3%, and other reservoirs 299 acres, or 0.1%. The total cost of irrigation systems up to July 1, 1910, was $15,014,090. The average cost of irrigation systems per acre of land irrigated was $31.91. The annual cost of maintenance and operation per acre in 1909 was $3.08.

Machine Shop Organization for the Manufacture of Small Devices in Quantities.*

By F. P. COX.†

The economical manufacture of small devices in large quantities is chiefly characterized by the attention which must be given to details. The cost of material is in general proportionally small, and is any case more or less fixed by the design; but the labor item is large and requires constant and careful scrutiny. Unlike other lines of manufacture, each operation is repeated over and over again and, therefore, warrants a considerable expenditure of time and money to determine exactly the best manner in which to perform it. It is desirable to know just how economically it can be performed even though temporary conditions prevent an immediate realization of possible results. This leads to scientific rate setting, and the advantages of such an experimental manufacturing department are too well known to require comment. It means automatic machinery for many operations, but not for all; it means suitable provision for stock handling, inspection, supervision, etc. In addition, it requires organization to provide for the proper correlation of these various elements and to insure their harmonious operation.

Many plans of organization along the same general lines are possible. The general lines are subject to variations at times, but they are all centered around the same principal object, the labor item. No manager will ever be able fully to realize his ideal system, and perhaps the chief reason will be found in the limitations of his assistants. An organization which has been in operation for any length of time will have developed a certain number of individualities which must be reckoned with in any contemplated change. It would be folly to dispense with a man of proved value because he doesn't happen to fit exactly in an ideal plan of organization. It is always possible to modify the system to avoid such a sacrifice and without any material departure from the original scheme.

An equivalent system can be devised with comparatively little difficulty, but the equivalent of a tried man is hard to find. Of course this does not mean that a weak man should be retained, nor that one not in sympathy with the plan of organization should be permitted to take part in its administration. Neither does it mean that any effort should be spared to find and employ a competent man to fill an important part in the general scheme. It does mean, however, that a man whose known limitations prevent him from filling all the duties of a certain position should have those duties so modified that he will not be prevented from filling those for which he has been found particularly adapted; and that one who has shown particular ability in handling two or more lines, not originally intended to be combined, may still exercise this talent by a reasonable modification of the system.

The organization here outlined probably differs very little from similar organizations intended to cover the same field.

Manager
- a Superintendent
  - (1) Production clerk
  - (2) Stock clerk
  - (3) Material list department
  - (4) Rate setting department
  - (5) Automatic tool department
  - (6) Shop accountants
  - (7) General foreman
  - (8) Inspectors
  - (9) Tool department
- b Engineer
  - (1) Designer
  - (2) Draftsmen
  - (3) Model room
- c Cost department

The strength of this organization lies in the fact that each feature of manufacture is under control of a man particularly qualified to handle it in the best possible manner, and that his responsibility is definitely fixed and limited to the proper performance of his own part of the work. There is no overlapping of responsibility and no possibility of misunderstanding. Any failure to produce a part is at once traced to the responsible party. For example, if a leading-hand finds that he is not receiving his parts in adequate numbers and is, consequently, handicapped, he at once reports to the stock clerk who has failed in his duty. The stock clerk realizes that he has failed. The mere absence of parts is convincing evidence of the fact, and he must correct the shortage before it becomes a limiting feature or report his inability to do so to the superintendent.

When everything is moving properly, if such condition should ever exist, the work of the various departments becomes routine, but the moment any trouble appears in the distance an alarm is sounded. If trivial in character, it is corrected without any great disturbance, but if important, it comes at once to the highest authority and the whole strength of the organization is applied promptly to correct it.

The functions of the different departments are, in general, sufficiently described by their names. It may be necessary to add that all material is ordered by the material list department but the following of the stock into and through the shop rests with the stock clerks, and that while the inspectors come under the superintendent the limits of inspection are set by the engineers.

The workman is the principal subject of study and every effort must be made to shorten the time and lessen the effort required to perform the operation for which he is engaged. It may mean automatic tools, increased facilities, improved methods, or the splitting of the operation so that a portion of it may be done by a less skilled operator, who is competent to do this portion in a satisfactory manner. Always inspection is involved in order that no time may be spent on a piece which is already defective and will ultimately be rejected or require special fitting, which is necessarily expensive. The proper time to reject a piece or to correct it is immediately after the false operation has been completed. In order that a workman may perform a maximum of work with a minimum of effort, it is necessary that the piece shall come to him in ample quantity and at a constant rate; that previous operations shall have been properly performed, and that the piece shall be promptly inspected and removed. His whole thought and effort should be given to performing his own operation satisfactorily. One portion of this desired result may be obtained by a large stock of parts, but this means unnecessarily large inventory and should be rejected. It is just as necessary that parts should not wait for the workman as it is that the workman should not wait for parts.

Regular and frequent meetings are held by the superintendent and his assistants, so that each may be familiar in a general way with conditions as a whole, but such meetings are not to be construed as lessening the responsibility of the different departments. These meetings require but little time if everything is going smoothly and justify the time taken if there is any prospect of trouble. Similar meetings are held weekly by the manager, engineer and superintendent, and are more or less generally attended by principal assistants. Change of design or method are freely discussed at these meetings, and they serve as a clearing house for all matters of interest which have come up during the week and which are not of sufficient importance to require instant attention.

Changes of design, unless to correct defects in the apparatus are docketed and not acted on singly as they arise. Low costs cannot be obtained where the design is continually changing, and minor changes should be held for an apparatus meeting. Such meetings are held at regular intervals of from three to six months. When a line of apparatus has but recently been placed in the shop, the interval is shorter than when it has become more firmly established and original troubles eradicated.

Apparatus meetings are attended by the manager, engineer, cost department and superintendent, with their assistants, who have the actual handling of the apparatus. The device is placed on the table and gradually dissected, each part being fully discussed as it is taken off, and the presence of the leading hand is considered essential during the discussion of the particular part or operation with which he is concerned. The leading-hand, or gang boss, comes under the general foreman. He has direct charge of a rather small number of operators, and often a portion of his time is given to productive labor. More than anyone else he appreciates inconveniences and difficulties which arise in producing his particular part, and any organization which fails to profit by such knowledge is fundamentally defective. Introduction of automatic tools, change of methods or of design, and quality of product are thoroughly gone into and after this meeting all changes decided upon are authorized at one time after which none are made until the next change period.

*A paper published in the June "Journal" of the American Society of Mechanical Engineers.
†Meter Dept., General Electric Co., West Lynn, Mass.

Specifications for the Purchase of Fuel Oil: U. S. Bureau of Mines.

The success which has attended the purchase of coal on a basis of heat value and in accordance with proper specifications[1] has led to a demand for similar specifications for the purchase of fuel oils. The U. S. Bureau of Mines has recently issued, in Technical Paper No. 3, the accompanying specifications. There were drawn up for the government, covering (1) the number of heat units obtained for a given price, (2) the physical character of the oil, (3) flash and burning points, and (4) amounts of extraneous matter.

General Specifications.

(1) In determining the award of a contract, consideration will be given to the quality of the fuel offered by the bidders, as well as the price, and should it appear to be to the best interest of the Government to award a contract at a higher price than that named in the lowest bid or bids received, the contract will be so awarded.

(2) Fuel oil should be either a natural homogeneous oil or a homogeneous residue from a natural oil; if the latter, all constituents having a low flash point should have been removed by distillation; it should not be composed of a light oil and a heavy residue mixed in such proportions as to give the density desired.

(3) It should not have been distilled at a temperature high enough to burn it, nor at a temperature so high that flecks of carbonaceous matter began to separate.

(4) It should not flash below 60° C. (140° F.) in a closed Abel-Pensky or Pensky-Martens tester.

(5) Its specific gravity should range from 0.85 to 0.96 at 15° C. (59° F.); the oil should be rejected if its specific gravity is above 0.97 at that temperature.

(6) It should be mobile, free from solid or semisolid bodies, and should flow readily, at ordinary atmospheric temperatures and under a head of 1 ft. of oil, through a 4-in. pipe 10 ft. in length.

(7) It should not congeal nor become too sluggish to flow at 0° C. (32° F.).

(8) It should have a calorific value of not less than 18,000 B.T.U. per lb.; 18,450 B.T.U. per lb. to be the standard. A bonus is to be paid or a penalty deducted according to the method stated under section 21, as the fuel oil delivered is above or below this standard.[2]

(9) It should be rejected if it contains more than 2% water.

(10) It should be rejected if it contains more than 1% sulphur.

(11) It should not contain more than a trace of sand, clay or dirt.

(12) Each bidder must submit an accurate statement regarding the fuel oil he proposes to furnish. This statement should show:
(a) The commercial name of the oil.
(b) The name or designation of the field from which the oil is obtained.
(c) Whether the oil is a crude oil, a refinery residue, or a distillate.
(d) The name and location of the refinery, if the oil has been refined at all.

(13) The fuel oil is to be delivered f. o. b. cars or vessel, according to the manner of shipment, at such places, at such times, and in such quantities as may be required, during the fiscal year ending .....

(14) Should the contractor, for any reason, fail to comply with a written order to make delivery, the Government is to be at liberty to buy oil in the open market and charge against the contractor any excess of price, above the contract price, of the fuel oil so purchased.

Sampling.

(15) Deliveries of fuel oil will be sampled by a representative of the Government. Whenever such action is practicable, the oil will be sampled as it is being delivered. The final sample will be made from samples taken from as large a proportion of the delivery as practicable, in order that the final sample may truly represent the delivery.

(16) The final sample will be sealed and forwarded to the Federal Bureau of Mines, Pittsburg, Pa., for analysis.

(17) If the contractor so desires, permission will be given him, or his representative, to witness the sampling of the delivery and the preparation of the final sample.

(18) The final sample will be analyzed and tested immediately after its receipt in Pittsburg.

Causes for Rejection.

(19) A contract entered into under the terms of these specifications shall not be binding if, as the result of a practical service test of reasonable duration, the fuel oil fails to give satisfactory results.

[1]For various specifications see Eng. News, Feb. 7, 1907; April 8, Sept. 9, Oct. 28, Dec. 23, 1909; Jan 26, 1911.

[2]It is important that the standard fixed should not be higher than can be maintained under the terms of the contract. In the absence of information as to the heating value of the oil, the Bureau of Mines will analyze samples taken from the deliveries to establish the standard heating value, expressed in calories or British thermal units. It will be to the best interests of the contractor to specify a fair standard for the fuel oil he offers, since failure to maintain that standard will cause deductions from the contract price and possibly the cancellation of the contract, while deliveries of higher quality than the standard will result in the contractor receiving premiums.

(20) It is understood that the fuel oil delivered during the term of the contract shall be of the quality specified. The frequent or continued failure of the contractor to deliver oil of the specified quality will be considered sufficient cause for the cancellation of the contract.

Price and Payment.

(21) Payment for deliveries will be made on the basis of the price named in the proposal for the fuel oil corrected for variations in heating value,[2] as shown by analysis, above or below the standard fixed by the contractor. This correction is a pro rata one and the price is to be determined by the following formula:

$$\frac{\text{Delivered B.T.U. per lb.} \times \text{Contract Price}}{\text{Standard B.T.U. per lb.}} = \text{Price to Be Paid.}$$

Water that accumulates in the receiving tank will be drawn off and measured periodically. Proper deduction will be made by subtracting the weight of the water from the weight of the oil deliveries.

The Bureau emphasizes the need of securing representative samples if any weight is to be given the results of tests on the samples submitted. Integrity, alertness and skill are deemed essential qualities in a good sampler. Particular watchfulness is urged for sand, water, etc.; suspicious circumstances are to be fully reported with special samples of questioned oil.

For sampling wagon deliveries, a pint dipper may be used; a dozen similar samples are to be caught at regular intervals, the total amount being thoroughly mixed and about 1 gal. retained. A continuous sample may be taken through a ½-in. cock on the outside of the delivery pipe. If the first dipperful shows water this is to be thrown into the receiving tank and not into the large sample.

If deliveries are to be continued over a considerable period—say a month—then only definite portions of the well-mixed large samples need be retained, these portions being transferred to a tinned can or drum having a tight bung. At the end of the series of deliveries, several round clean stones are to be put into the can or drum which is to be well rolled to insure a thorough mixing. About 1 gal. is to be retained as the final sample. If the can or drum is to be re-used, it should be cleaned with gasoline and dried.

Special methods are given for sampling a large reservoir where water and earthy matter settles on standing and where the oil is apt to stratify. The Bureau recommends that, before sampling, the tank should be dredged with a long-handled dipper; if any considerable sediment is brought up the oil should be rejected. On account of the disturbance of such dredging which, however, does not approach thorough mixing, it would seem better to dredge after sampling. For the sampling a pint bottle may be fixed to a long pole and fitted with a loose stopper at the end of a long string. The empty corked bottle is immersed to the desired point and the stopper pulled out. Bottlefuls taken from proper points throughout the mass of the oil when properly mixed will give an excellent gross sample from which to take the final 1-gal. sample.

An alternative scheme is proposed. The sampler has a 1-in. tin tube long enough to reach to the bottom end of the tank. A conical plug is fitted at the bottom end of the tube and a stiff strong wire runs up through and beyond the upper end for easy manipulation The sampler drops the plug several inches below the bottom of the tube and allows the vertical tube to sink slowly through the oil to the bottom of the tank. Care is to be taken not to agitate the oil and to cut a representative core. When the tube is on the bottom the plug is pulled up and the tube struck against the bottom to ram the plug into place. The tube is then removed and emptied. It may often be desirable to core a reservoir at regular spaced points, mixing the cores for the final gross sample. The usual 1-gal. final sample is taken from that.

A single drum may be similarly sampled with a glass tube. The tube, open at both ends, may be allowed to cut its way slowly to the bottom. The upper end may then be closed by the thumb or finger of the hand holding it and the tube wiped with the fingers of the other hand as removed.

Caution is given against storing the sample in an iron can or drum; the iron absorbs sulphur by long contact with a sulphur-content oil—sulphur which is lost to the analyst.

Samples are to be forwarded to the analyst preferably in a tin can because least liable to breakage. The cap is to be soldered tight in all cases. About ⅛-in. air space should be left for expansion of oil. The can is to be sealed as soon as filled to avoid volatilization of lighter constituents. The can is to be carefully cleaned and examined for leaks and pin holes. The label should be carefully written with a hard lead pencil on a strong mailing tag; the pencil should be pressed firmly to indent the paper, giving an inscription legible even after becoming soaked with oil.

[2]The value of an oil as fuel is in proportion to the total combustible matter it contains as shown by its heating value. This value may be expressed in small calories per gram or B.T.U. per pound. Sulphur, moisture, and earthy matter lower the heating value of an oil and decreases the furnace capacity; they also may have a deleterious effect on boiler and furnace, and may impair the operation of burners.

Unwatering a Mine by Horizontal Drill Holes.

A novel and interesting method of unwatering a flooded mine has been carried out successfully in the tin mining district of Cornwall, England. Owing to the discovery of surface deposits some 15 years ago the price of tin dropped to about $150 per ton, and this, with the cost of getting out the deep lying ore, led to many of the mines being abandoned. When the surface deposits became exhausted, the price of tin went up to about $1,070 per ton and is now about $900 per ton. This change in condition led the mine owners to consider methods of unwatering their mines and resuming work. The Phoenix Mine Co. has a shaft 800 ft. deep, with many miles of headings, while a quantity of ore already mined was known to be ready for removal and there are still large bodies of ore to be worked. The shaft was full of water to within 100 ft. of the top, but unwatering could not be done through this shaft, as it was inclined and partly blocked; there was also the difficulty of adjusting the pumping plant at different levels. The plan adopted was to sink a new (vertical) shaft both for pumping and to form a future working shaft, and to drive drill holes from this into the mine workings so as to tap the water in the latter.

The methods and plant used are described in "The Engineer" (London), from which the cut and the following description are reproduced:

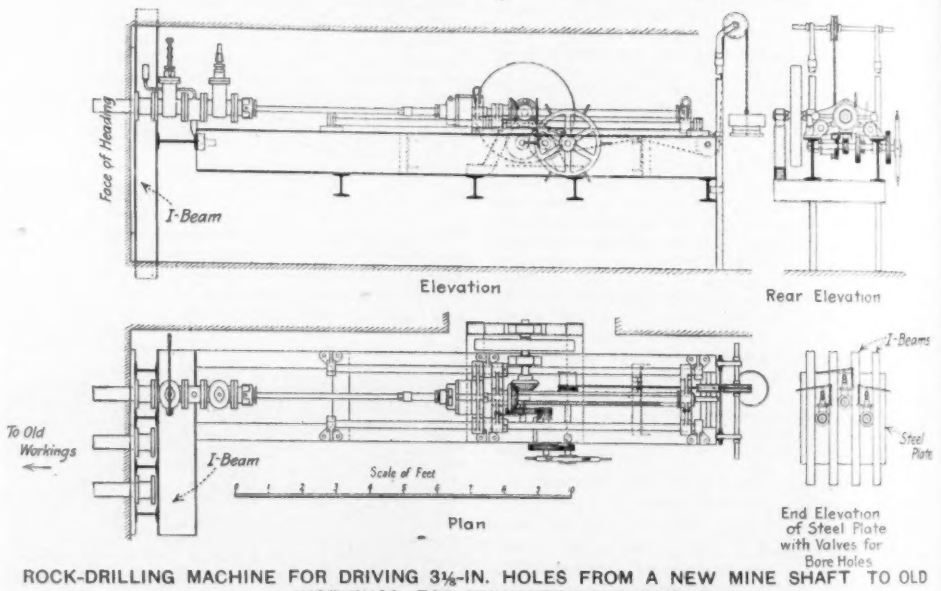
The deposit of tin ore is divided into two portions by a mass of gray granite going down to and below the full depth of the workings. A new shaft was sunk down to the full depth of 800 ft. in this solid granite to serve the double purpose of unwatering the old workings and of affording a means of access to the deposit on the other side of the granite wall. A powerful Cornish pumping engine was erected at the surface; it is capable of raising 48,000 gals. of water per hour, its spears (or pump rods) being nearly 800 ft. long. The new shaft was at a distance of some 300 ft. from the old workings. From its bottom a horizontal heading, measuring 8 × 8 ft., was driven in the direction of the old workings for a distance of 220 ft. to a point estimated to be about 87 ft. from the old workings.

It then became a question as to the proper method to employ in making an actual connection between the old and the new workings. To have bored through without taking precautions to regulate the flow of water would, of course, have meant disaster. After a consultation between Mr. W. Nance Williams, manager of the mine, and the company's consulting engineer, Mr. Nicholas Trestrail, it was decided to bore small horizontal holes through the remaining 80 ft. or so of granite, and to provide some means of checking the water. The consent of the Inspector of Mines was obtained to this course, provided that the means of checking were efficient.

Several engineering firms were invited to suggest schemes. Among these was the firm of C. Isler & Co., of London, whose proposal was accepted. Mr. Frank Meyer, a director of that firm, had charge of the operations. He came to the conclusion that the best method to employ would be to make vertical and smooth the face of the heading, and then to secure against it a thick steel plate held in position by four I-beams let into the granite top and bottom, the whole being grouted with cement. While this was being done, Mr. Meyer had designed and built in Messrs. Isler's works a powerful horizontal boring machine of an entirely new form. A drawing of the apparatus as erected in the heading is given in the accompanying cut.

The boring was done by means of a steel crown set with diamonds. The feed was practically automatic being actuated by the weight shown running over the pulley, coarse adjustments being made by the capstan wheel. The boring rods were hollow, and water was supplied through them to the tool at a pressure of 150 lbs., this being provided from tanks fixed in the new shaft. The machine was driven by a small horizontal steam engine worked by compressed air, the compressor for this being at the surface.

Three 4-in. holes were bored in the steel plate, each being provided with a leading tube flanged to the plate. Attached to this flange were two 4-in. sluice valves, as shown. One was a quick-closing valve and the other a screw-down stop valve. In front of these valves a length of tube (not shown in the drawing) was provided and flanged to the valve, so as to allow the boring tool to be drawn past the valves without actually taking it out of the tube. At the end of this tube was fixed a stuffing-box and gland which could be unscrewed to allow the tool to pass through. The turned portion of the rod could, of course, be revolved in and advanced through the gland. This pipe was not necessary when boring through solid granite, but became so when the old workings were approached. There was an outlet controlled by a valve to permit the water used for boring purposes to flow out, and to allow of the bore hole being occasionally flushed out to clear it of grit. Only one bore hole was driven at a time.



ROCK-DRILLING MACHINE FOR DRIVING 3⅛-IN. HOLES FROM A NEW MINE SHAFT TO OLD WORKINGS, FOR UNWATERING THE MINE.
(C. Isler & Co., London, England; Builders.)

It was thought possible that the boring would have a tendency to drop or curve forward, but this did not occur. The actual distance bored before the old workings were pierced was 87 ft. The mine company was responsible for the direction of the bore, and the calculations of its engineers were proved to be entirely correct. The boring was started on Jan. 28, and the main body of water was tapped on Feb. 28. The whole work went forward without a hitch. The first part of the boring was in solid granite, and the material is singularly compact. The last 47 ft. of material was, however, somewhat broken and fissured. This caused a rather slower rate of progress than had been the case in the solid granite, because the cores occasionally broke and jammed.

There was an exciting incident just as the boring was completed. The first rush of water brought with it a large quantity of grit which jammed the boring tool in the valves and prevented them from being closed. Fortunately, this had been foreseen and provided for, and the workmen stuck to their posts, so that in a short time the tool was freed and the valves closed. Men standing 40 ft. away were slightly cut about the face by the grit from the hole, so great was the force of the water when the valves were opened. The noise made by the water as it issues from the valves is terrific and deafening.

As soon as the tool was withdrawn and the valves were closed the water was absolutely under control, and could be shut off or let into the heading at will. The pressure shown at the mouth of the hole when the valves were closed was 2[illegible] lbs. per sq. in. It was anticipated that it would be higher than this, but it is thought that some of the pressure may be dissipated through the fissures in the rock. The size of the bore hole was 3½ ins. in diameter, and the water running from it down the heading and into the sump at the bottom of the shaft requires nine strokes of the pump per minute to keep it down. The capacity of the pump is 70 gals. per stroke, so that the amount of water flowing through the bore is some 37,800 gals. per hour.

At a later period, when the pressure has been reduced somewhat, it is proposed to put in another bore hole, but at present as much water is coming through as can be conveniently dealt with. The third hole proposed may not be needed, though it will be made if it is. It is anticipated that the mine will be unwatered in some four months.

A British Example of Electrolytic Corrosion of Steel in a Reinforced-Concrete Structure.

In connection with an investigation into the corrosion of steel or iron in reinforced concrete being conducted by the Concrete Institute, of London, a deputation of British engineers paid an inspection visit to four reinforced-concrete piers, docks or jetties in the harbor at Southampton, Eng. All of these structures are in tidal sea-water and all are of sufficient age to present valuable information as to the behavior of such construction. The committee, which consisted of Messrs. H. K. G. Bamber, Assoc. Inst. C. E.; Mr. C. F. Marsh, M. Inst. C E., and Mr. F. S. Wentworth-Shields, M. Inst. C. E., all prominent engineers interested in concrete work, presented a report which was abstracted in the papers of the Concrete Institute, as follows:

COAL BARGE JETTY.—This is about 360 ft. long, and consists of a reinforced-concrete deck 20 ft. wide, resting on reinforced-concrete piles placed in bents of three, the bents being spaced 10 ft. apart. The total height of the jetty from dredging level is 34 ft., of which 19 ft. is above and 15 ft. below low water. The jetty was built in 1902, and is therefore about eight years old. [Examination made May 31, 1910.—Ed.] It is stiffened by transverse and longitudinal diagonals, and by longitudinal and transverse struts near low water level.

The deck supports four large traveling electric cranes, which are almost constantly engaged unloading coal from steamers into barges. The cranes weigh about 70 tons each.

It was noticed that there had been a considerable amount of deterioration in the underside of the deck and in the upper portion of the piles and diagonals. The steel bars and stirrups had evidently rusted inside these members to such an extent that the concrete had been cracked, and in some cases completely burst off. The worst of this rusting had taken place on the underside of the deck beams. On cutting away the concrete it was found that the stirrups, which were very close together, had in some cases got displaced during construction, causing small voids between the stirrups and the bars which they surrounded. Both stirrups and bars were often quite wet and thick with rust. The stirrups were often eaten through and parts of the bars covered with a coating of rust ⅛-in. to ¼-in. thick. The piles and diagonal struts, where no displacement of the stirrups had taken place, were similarly affected, but to a lesser extent.

It was further noticed that, although a very large proportion of the piles, beams, and struts had been affected in this way, the damage was wholly above high water of neap tides, and that below that level the reinforced concrete was apparently in perfectly good condition. The concrete when cut away seemed for the most part to be dense and strong. It was said to consist of Portland cement and Southampton gravel with the natural sand in it, mixed in the proportions of 1 to 4. A subsequent chemical analysis confirmed these proportions. It was noticed that the heavy cranes unloading coal from a vessel alongside seemed to shake the jetty somewhat as they swung across, and it was ascertained that one or two piles had been damaged by vessels colliding with the jetty.

OLD EXTENSION QUAY BERTHS 30 TO 33.—This consists of a reinforced-concrete platform built alongside an old quay wall in order to widen the quay. It was about 1,500 ft. long, and consists of a timber and steel joist decking resting on reinforced-concrete beams and piles. The quay is 50 ft. wide and the piles are placed in four rows, about 40 ft. apart longitudinally and 12 ft. laterally. The total height of the jetty from dredging level is about 49 ft., of which 19 ft. is above and 30 ft. below low water. There is a line of longitudinal, transverse, and diagonal bracing about 4 ft. above low water, but no bracing below this level. On the decking is placed two lines of railway carrying trucks to and from the ship's side, and a pair of crane rails for a series of hydraulic cranes, each weighing about 60 tons. The traffic on this quay is exceedingly heavy. The quay was built in 1902-5, and is therefore about five to eight years old.

On this quay a certain amount of deterioration was also noticed; but it was nothing like as bad as at the coal barge jetty. The reinforced-concrete beams are rectangular in section and not connected by slabs. They contain a very heavy proportion of steel (about 3%), and the stirrups are very close together. Moreover, it is evident that some of the stirrups have got displaced during construction, and caused voids in the concrete. It was principally in the underside of these deck beams that the deterioration was noticed. A few of the piles, however, were also affected in the same way.

JETTY AT WOOLSTON.—The next structure visited was a reinforced-concrete jetty at Woolston, at the works of Messrs. John I. Thornycroft and Co., Ltd. This is a small jetty consisting of a reinforced-concrete deck on piles of the same material braced together by struts and diagonals. It is used as a quay for fitting out ships which are being built by Messrs. Thornycroft, but it has no railway lines, and although equipped with one crane, this crane is supported on an independent foundation. The design of this jetty appears, however, to be lighter than that of the other two jetties here described. It was constructed about 1899, and is therefore about eleven years old.

This jetty is probably the oldest reinforced-concrete structure of its kind in the country. The deputation were interested to notice that its condition was all that could be desired. There was no sign of deterioration anywhere, and the rusting action which had been noticed on the other two jetties was here entirely absent.

TOWN QUAY.—The deputation next visited the Town Quay at Southampton, belonging to the Southampton Harbor Board. Mr. Cooper-Poole, the engineer, kindly gave the deputation all facilities for seeing it. The Town Quay consists of a jetty which has been built and renewed at many different times. A large proportion of it has been rebuilt in reinforced concrete. In every case where this material has been used the structure consists of a reinforced-concrete decking, resting on piles of the same material, and braced together by reinforced-concrete struts and diagonals. The oldest reinforced-concrete work here was built about six years ago.

It was noticed that generally speaking the work was in excellent condition. No signs of rusting or deterioration could be seen on the decking, but in one or two cases cracks were noticed on the piles. Here again, however, as far as could be seen, the deterioration had taken place on the upper portion of the piles, and not below water.

SUMMARY.

The deputation were, therefore, confronted with some very curious facts. On the one hand the coal barge jetty, eight years old, had suffered severely from rusting and deterioration of the reinforced-concrete work, the damage being confined almost entirely to the underside of the decking and to the piles above high-water level. On the other hand, the jetty at Messrs. Thoryncroft's works, which is three years older, had suffered no deterioration whatever.

It was at first thought that possibly the difference in behavior of these two structures must be due to the fact that one of them, the coal barge jetty, was subjected to heavy racking stresses from the cranes working upon it, and that the structure was not sufficiently rigid for the work it had to do. Although this may be a contributing cause, it was not altogether possible to account for the deterioration in this way, because it was noticed that the southern end of the jetty, on which the cranes never rest, was quite as much affected as the other portions. Again, it was thought that perhaps the trouble at the coal barge jetty was due to the misplacement of the steel stirrups. This, however, would not wholly account for it, as deterioration has also taken place in parts of the structure where the steel was found to be well placed, and where apparently the concrete had been very free from voids. Another cause suggested was that the qualities of the two concretes might be different. The aggregate in each case was the same, Southampton River gravel, which is undoubtedly a first-rate one; but whereas at the coal barge jetty the gravel and sand had been used as mixed by nature, at Messrs. Thornycroft's jetty it had been separated and re-graded. A chemical and physical analysis was, however, made of specimens of each concrete cut away from each of the jetties, and it was impossible to trace any difference between them in this respect.

ELECTROLYTIC ACTION.—It was also thought that the deterioration at the coal barge jetty might be due to electrolytic action, and an investigation was subsequently made by the Docks Engineer at Southampton, which undoubtedly showed that such an action was going on. It was found that the return wire of the lighting circuit of the jetty was earthed to a plate-girder bridge which is supported on the reinforced-concrete work at the southern end of the jetty. This girder is so placed that the current has to find its way to earth either through a water main which is supported under the bridge, or through the reinforced-concrete work. It was found that when the lights were turned on there was a distinct difference of potential between the steelwork of the bridge and the water below of 9 to 10 volts, and that when a direct connection was made, a current of about fifteen amps. passed. The concrete of the decking was cut away at two or three places and the steel reinforcement exposed. The steel at these places was metallically connected with the water below, and a difference of potential of about 0.04 volts was observed when the lights were working. There seems to be no doubt that for the past eight years a small proportion of this current has passed from the bridge to the water through the reinforced-concrete work, whenever the lights have been used, and it is more than probable that this accounts very largely, if not wholly, for the rusting action in the steel.

Some observations were next made at the Old Extension Quay, where, as mentioned before, a similar rusting action has gone on to a minor extent. The steelwork of the reinforced-concrete deck beams was cut into at three places, and a metallic connection made with the sea water below. It was found that a difference of potential of 0.11 volts was recorded. It was difficult to trace the cause of this charge, but it was noticed that the rails on the quay were at a still higher potential (about 0.30 volts), so that it seemed probable that the current was passing from these rails to the water (or vice versa) through the substance of the reinforced concrete.

To confirm the truth of this explanation, a careful analysis of samples of the rust from each of these two structures was made, and it was found that the following compounds were present:

	Coal barge jetty.	Old extension quay.
Magnetic oxide of iron (Fe_3O_4)	3.37%	4.47%
Ferric oxide (Fe_2O_3)	79.01%	81.01%

The presence of the black magnetic oxide of iron is additional evidence that the rusting is due to electrolytic action.

No special electrical observations were made at the Town Quay, but, as this quay carries railroads in direct connection with those of the old Extension Quay, and is equipped with electric cranes, it seems very probable that the slight deterioration noticed at the former structure may proceed from the same cause.

The Docks Engineer was able to inform the deputation that two other minor structures on the Dock Estate, consisting of reinforced-concrete piles driven in the sea water, had suffered no deterioration whatever. These structures are isolated retaining walls, and are not near rails or anything which could conduct electric currents to them.

The deputation were strongly of opinion that the unusual deterioration observed at these structures at Southampton was directly due to electrolytic action, caused by slight currents passing through the substance of the reinforced concrete, and that the absence of such defects of Messrs. Thorneycroft's jetty was probably due to its being free from such electrolytic action.

Improved Foundry Irons.—At the recent Pittsburg convention of the American Foundrymen's Association, Dr. Paul Herault, of Paris, France, called attention to the use of electric furnaces for improving the quality of foundry irons. The main feature of what he called a "strong" iron was low sulphur content. To secure this melted pig is run into the electric furnace and heated under a basic slag which does not have to be scraped or removed except when teemed into a ladle with the metal. Carbon, silicon, manganese and phosphorus are not affected unless desired. Common Bessemer iron, worth from $10 to $14 per ton, can be changed, it is claimed, into "strong," "car-wheel," "cold-blast-charcoal," etc., for about $1 per ton.

A Telferage System for Handling Baggage at an English Railway Station.

An interesting development in the introduction of the electric telferage system is its application to the handling of baggage in a large railway station. This installation has been made by the Lancashire & Yorkshire Ry. at its Victoria Station in Manchester (England); as mentioned in our issue of May 25. Its special purpose is the handling of light baggage and parcels between the parcel office and the train platforms. The parcel service corresponds very closely to the express service of this country, but is in the hands of the railway companies instead of independent companies. The baggage and parcels rooms at this station are at the street level, below the train floor level. The heavy baggage is moved on trucks which are wheeled over a bridge spanning the tracks and platforms, elevators connecting the bridge with the several platforms and with the lower floor.

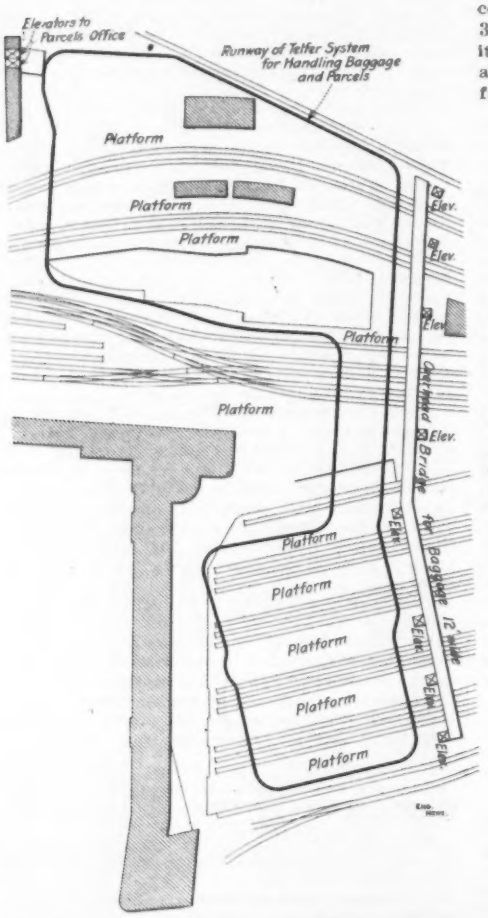


Fig. 1. Plan of Runway for Telferage System Handling Baggage at the Victoria Station, Manchester (England); Lancashire & Yorkshire Ry.

The parcels office is at one corner of the station, as shown by the plan in Fig. 1, and the telfer runway forms a continuous loop of approximately dumb-bell form, there being no branch lines and consequently no switches. The total length of this runway is 2,448 ft. The runway consists of a pair of flat steel bars 11¼ ins. apart, and these are bolted to the legs of horseshoe yokes or hangers. The yokes are suspended from the roof trusses by rods, and the runway is steadied by lateral stay rods and guys. The arrangement is shown in Fig. 2.

The telfer or trolley hoist has four double-flanged wheels 10 ins. diameter, with a wheel-base of 11½ ins. The two wheels on each side are connected by coupling rods, only one pair of wheels being driven directly by the motor. The telfer is about 2 ft. 7 ins. long, or 4 ft. including the frame from which is suspended a leather "hammock" seat for the operator. The construction of the telfer is shown in Fig. 2. The motor is of ½-HP. and has a vertical shaft which can operate either the driving wheels or the hoisting drums, the power being transmitted in either case through worm gearing. The hoist has grooved sheaves for link chains, and the chains are not coiled upon the sheaves but pass to a box or carrier hung beneath the sheaves, as shown. Owing to the rather heavy wear and tear in the clutches and chain sheaves it is proposed to substitute wire ropes coiled upon barrels or drums.

The hoist has sling chains for the attachment of a large basket in which the baggage or parcels are placed. This basket is 5½ × 3 ft., and 3 ft. deep; it is fitted with small wheels so that it can be moved easily in the parcels office or along the platform. The hoisting speed is 24 ft. per min., and the traveling speed is 5 m. p. h. The weight is 1,286 lbs., distributed as follows: telfer carriage, 608 lbs.; motor, 216 lbs.; basket, 362 lbs.; operator (boy), 100 lbs. The carrying capacity is 1,100 lbs. Fig. 3 shows the telfer in operation, with loaded basket attached.

This baggage-handling telferage system is the invention of Mr. John A. F. Aspinall, M. Inst. C. E., General Manager of the Lancashire & Yorkshire Ry., and we are indebted to him for plans and photographs.

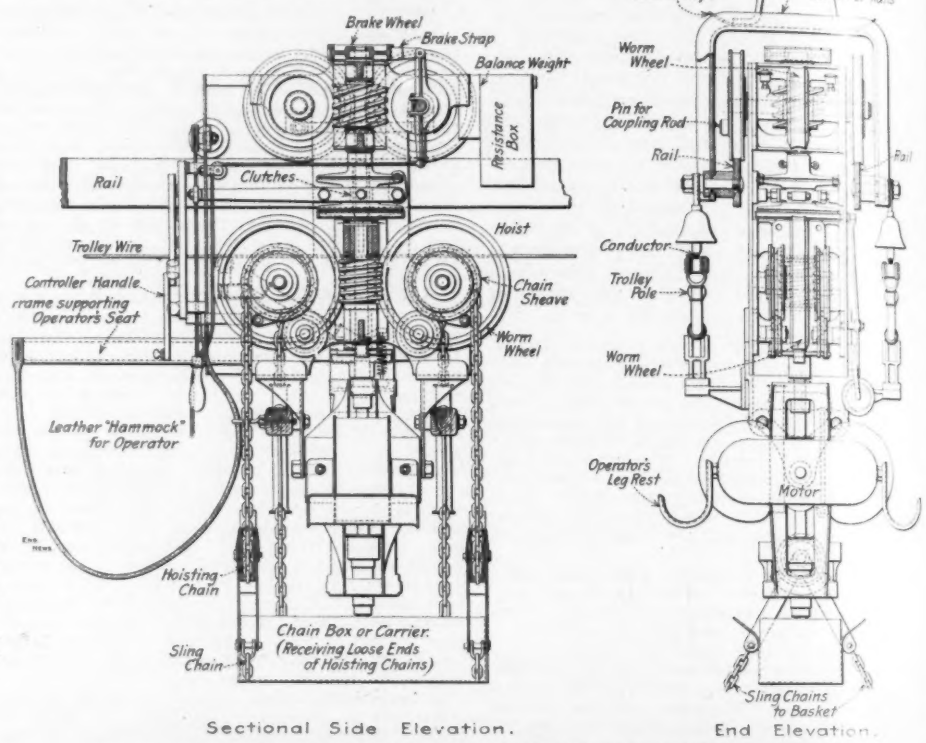


FIG. 2. ELECTRIC TRAVELING TROLLEY HOIST FOR HANDLING BAGGAGE.

FIG. 3. BAGGAGE-HANDLING TELFER SYSTEM IN THE VICTORIA STATION AT MANCHESTER (ENGLAND).

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The Equipment of the New Chicago & Northwestern Passenger Station in Chicago.

The mechanical equipment of the new Chicago terminal station, which is described elsewhere in this issue, includes three features of more than ordinary interest. These are the belt conveyors for train mail, the vacuum cleaning system, and the garbage cremator.

The almost universal system of handling mail from incoming trains is to load the sacks or pouches upon ordinary baggage trucks which are hauled away by hand, generally along the passenger platform, but sometimes on a narrow baggage platform between the tracks or in a subway beneath the train floor (the trucks being raised and lowered by elevators). At the new Chicago station, the sacks are thrown upon belt conveyors running in troughs between the tracks, and are thus delivered to chutes which discharge them upon the sorting tables of a sub-post-office on the lower floor of the station. Outgoing mail is delivered by elevators to cars standing on short stub tracks independent of the train or platform tracks; in this way the work can be done independently of the trains, and the cars then transferred to their trains at the proper time.

At the new Pennsylvania R. R. station in New York, chutes are provided for delivering outgoing mail cars, as noted in our issue of April 13, 1911, the train floor in this case being beneath the street level. In both cases, material advantages accrue in the rapid and convenient handling of mail, and the avoidance of interference with passenger traffic in the station.

It is of interest to note, in this connection, that the Chicago Post Office had at one time a system of underground transportation for mail between the general post-office, the sub-offices and the railway stations. This was provided by the narrow-gage underground railway freight tunnels. The tunnel cars were loaded by chutes at the post-office, and at the stations they were raised to the mail platform by elevators. Unfortunately, when the contract expired, the Post Office Department considered that the price asked for renewal was too high. A return was made therefore to the old wagon system, which is not only slow but is subject to delays in the crowded streets and at the numerous drawbridges.

The vacuum-cleaning system is one of the latest developments in the application of labor-saving appliances to sanitary work. A number of buildings use the machines, but at the Chicago & Northwestern Ry. station there are ducts or flues built into the walls for carrying the dirt direct from the portable sweepers to a chamber in the basement, from which it is flushed into a sewer connection. A few men operating this system can do better work and more work than a large number of men with brooms, while the unsightly appearance of rows and piles of dirt being swept up in public places is avoided. But the great advantage is in regard to sanitation. Hand sweeping necessarily stirs up dirt and dust, which thus becomes distributed through the atmosphere, to be breathed by the public or to settle again until the next sweeping is done. With the vacuum system the dirt is drawn at once from the floors, furniture, etc., and carried off once and for all in a manner that involves no danger or discomfort to persons in the building.

The garbage plant is another rather notable feature. The restaurant, lunch rooms, etc., necessarily produce large quantities of waste food material and refuse, but the very general practice is to store this in cans which are removed periodically by wagons. It is almost impossible to avoid odor and offence in this method. Some Chicago buildings in which restaurants are maintained have fitted their service boilers with a perfect-combustion furnace which enables this waste material to be burned effectively and economically, but the new railway station plant includes a special cremator for this purpose. The three installations which we have mentioned above indicate the variety of service to be considered in the planning of railway terminals, and indicate also some developments both in lines of sanitation and in the mechanical handling of material to ensure facility and rapidity of service.

Telferage System for Handling Baggage.

The handling of baggage between trains and baggage rooms at large railway stations with rapidity and facility and without undue interference with passengers or obstruction of the train platforms is one of the difficult problems in the design of modern terminal stations. The hand truck is employed almost universally for transportation (with the electric motor truck in a few exceptional cases), but to limit its use on the train platforms two methods have been employed; in one case narrow platforms for the exclusive use of the trucks are placed between the tracks (alternating with the wider passenger platforms); in the other case the trucks are handled in subways or lower floors (or sometimes on upper floors) and are raised and lowered by elevators. In some cases there is an elevator at each end of the platform, one at the inner end for baggage from incoming trains and one at the outer end for that sent to outgoing trains. A system of overhead conveyors and inclined chutes has been tried at one of the terminal stations in Paris (France), and an English railway has made an interesting application of the electric telferage system for a similar purpose, although this latter case is mainly for the handling of parcels service, which is distinct from the ordinary baggage service. This telferage installation is described elsewhere, and is of particular interest in view of the increasing attention which is being given in this country to the adoption of this system for freight handling purposes at railway freight stations and at industrial plants. In the telfer system, the baggage or freight is loaded upon carriers which are raised by traveling trolley hoists running on an overhead runway.

This system requires, of course, ample headway, so as to raise the load clear of passengers or teams; this prevents its application to many freight houses and warehouses having stories of ordinary height, and prevents its application to passenger stations having low trainsheds or independent platform shelters. In passenger stations, also, the runway and its supports may be objected to as presenting an unsightly appearance. But in the case of an existing station, where improved facilities are desirable and sufficient head room is available, this question of aesthetics may be of very minor importance. As compared with the construction of subways and elevators, it is practically certain that for a telferage system the cost would be very much less, while the former system would still require the transportation by trucks over practically the entire length of the platforms. In a freight house there is no fixed course of travel, as material delivered at any one door may have to be transferred to any one of the outgoing cars, or transported from any one car to any of the team loading points. For baggage service the problem is simplified by the fact that, as a rule, the outgoing material is distributed from one point (the baggage room) and incoming material is delivered to the same point.

Friendly Advice on Water Waste in New York City.

Under the pertinent title "New York's Water: Wilful Waste and Woeful Want," our London contemporary "The Surveyor and Municipal and County Engineer" comments on the danger of the shortage of the supply during the present season. The surveyor says:

> In the face of the fact that the consumption per head, even under the pressure induced by imminent danger of a shortage in the supply, is still well over 100 gals. per head per day, we are unable to agree with our contemporary, Engineering News, in the view that it is urgently necessary to take steps to overcome the legal and other difficulties in the way of obtaining a supply from Ten-Mile River. The water-supply of so great a city as New York is necessarily a matter of interst to British engineers, who, from their experience of many countries and climes, and their familiarity with every kind of manufacturing and mixed population, are well aware of the fact that even so little as 100 gals. per head is an excessive daily supply for any city. To reduce New York's consumption to 80 gals. per head forthwith, and by military force if necessary, is, in our opinion, the plain duty of the Government of the State, aided, if necessary, by the United States Government. The farce is played out, and if New York persists in neglecting the obvious and proper means of making her ample supply a sufficient one, she will in this respect take rank below the worst of the barbaric nations in the matter of public control of public affairs. Even a temporary substitute for an Ethiopian Sultan would not, in such a matter, be a cypher in his wn house.

As we have previously pointed out, the water-waste problem in New York City is something which, while quite within the capacity of engineers, is unfortunately not in their hands for solution. Instead, it is in the hands of laymen city officials. These, in turn, have been put in office by immense numbers of uninformed voters who, like the officials, have only a little knowledge of water-works administration—and that little is badly perverted.

It seems amusing, if not surprising, that our contemporary should think that the United States Government has authority to regulate the water consumption of any city outside of Washington. It would be scarcely less possible for King George or for the editor of the Surveyor himself to reduce water waste in New York City than for the U. S. Government to do it. At the same time, in view of the shameful way in which water waste has been neglected in New York City and the admirable manner in which it has been curtailed in nearly all British cities, and in view also of the water shortage which has hung over New York City as a possibility for years past, we do not wonder that a foreign writer, unfamiliar with the minutiae of the relations between our federal and state governments, should have been led into what, in view of the actual facts, is an extravagant assertion.

New York City Charter Meddling.

While a rapidly increasing number of American cities, particularly in the western part of the country, are achieving a large and almost absolute measure of home rule in charter making, the great City of New York is still at the mercy of politicians at Albany who are threatening to enact a new charter for the metropolis. We shall not take time and space to go into the details of this latest exhibit of total disregard of the wishes of New York City and complete ignoring of the large amount of earnest and thoughtful work which has been put upon charter amendments by many experts in charter making and in municipal government during the last five or ten years. All that it seems necessary to say here is that, so far as we can gather, the proposed new charter deserves little but condemnation. We understand that hearings upon it will be given during the present legislative recess, the hearings to begin on Aug. 21. Although that is the time of the year when a large percentage of those competent to speak upon the subject are always out of the city, it is nevertheless to be hoped that the opposition to the new charter will be so strong and so cogent that when the legislature reconvenes to conclude its special session it will abandon this attempt to impose an ill-considered charter on New York City. If the legislature persists then we hope Mayor Gaynor will realize that it is his duty to veto the bill, even though rightly or wrongly it has become known as the "Gaynor Charter." If the bill does go by Mayor Gaynor, there is good reason to hope that it will be killed by Governor Dix.

The subject may seem to be foreign to our columns and local in character, but good city government is a matter which vitally affects a large percentage of the readers of Engineering News and they should be awake to everything that menaces it, whether in New York City or elsewhere.

What Can the Engineering Profession Do to Improve Its Position?

There may be some among our readers who, on reading the above title, will question whether engineers need to do anything to improve their position. There are plenty of platitudes in print describing the grandeur of the engineer's work, the heavy responsibilities he carries, his advantage over other men in being able to make his work an imperishable monument to his ability. We think, however, most engineers who are daily confronted with the bread-and-butter problem will agree that the present position of the engineering profession leaves very much to be desired.

It is generally agreed, we take it, that at least nine out of ten members of the profession are receiving less for their work than what can be considered a fair compensation, when the degree of responsibility, the uncertain tenure of the employment, the long period of training and experience required to attain a high position in the profession, and the income earned by successful men in other lines of work are all taken into account.

The excéptions to this rule—the engineers who are amassing a competence or wealth—are very largely the men who have given up the professional practice of engineering and taken up some line of business. It is often said that engineering is a poor business. There is, however, plenty of good and profitable business in connection with engineering work.

Certainly, this situation is not one to be approved. It will be admitted, of course, that the professional man in any line of work, if we except the modern surgeon and the corporation lawyer, does not expect to gain a fortune, as fortunes are rated nowadays, in purely professional work; but at least he ought to gain a comfortable living and a chance to save a competence for his family and his old age.

It need not be said that engineers are mercenary in holding that the work of their profession ought to be better paid. It is well understood that the public to-day pays scant honor to success, unless that success can be translated into terms of dollars and cents. The engineer wants a larger income not alone because of the income or because of what it will yield for himself and his family, but because he realizes that his position in the community in which he lives and the respect that he and his fellow-members of the profession can command is greatly reduced if he is compelled through meager salary or inadequate fees to live on a scale far below that of his neighbors. And what applies to the man in the higher ranks of the profession applies also to the younger men, —to the rank and file, clear down to the beginners. We find men doing work requiring expensive education, a high degree of skill and, more than all else, a high grade of honor and trustworthiness. We find men meeting all these requirements and yet receiving compensation which is too often below that of the skilled workman who is a member of a union.

We shall not attempt to discuss in detail the causes which have led the engineering profession into this situation further than to say that they are traceable in general to the reaction in higher education against the old-time training which led nowhere and to the widespread desire among well-to-do parents to fit their sons for the work of a profession rather than for a business career. Whatever the causes, they are beyond the power of the engineer to remove.

The fact must be faced that the profession is overcrowded at the present time and will continue to be overcrowded for a long time to come. This means that the supply of engineers is in excess of the demand and that by the process of competition, wages, salaries and fees inevitably tend toward a minimum below which the supply is reduced by men taking up some other line of work.

It has been seriously proposed by some engineers to follow the example of the trade union and attempt to limit competition and fix a standard scale of wages for draftsmen, instrument men, etc.

It is extremely doubtful whether such a plan could possibly be made operative and whether, in the event that it could, it would be, on the whole, a benefit to the profession. Inevitably, by such a procedure the profession would forfeit something of the public esteem which it now enjoys. Further than this, it must be admitted that to a certain extent competition is beneficial to the profession. If we can have competition that will enable the best and ablest men to rise to the top, competition that will displace the third-rate and fourth-rate men, because men of greater ability can be found to fill their places, we might then see an actual benefit to the engineering profession from competition.

In order to view this question in an intelligent and constructive way, we must view it from the side of the public as well as from the side of the engineer. The public complains that the work of the engineer too often is poorly done. There are too many mistakes; there is too much extravagance. The men dealing with large affairs claim that, while there are plenty of engineers who can do this or that or the other special task, they do not know how to find engineers whom they know to be trustworthy to deal with the largest problems and not make mistakes. It is recognized that such engineers when they can be found are literally worth their weight in gold. In high positions of executive responsibility, the engineering management often makes all the difference between profits and losses; between success and failure.

It is not often realized, we believe, how difficult is the task of the man who wishes to employ a competent engineer, and how much more difficult the task is than it was 25 years ago! Not because there are fewer competent engineers, by any means; but because engineering work covers a far wider range, and the profession has grown so large that engineers themselves are often at a loss to find the right man for a special task. It must be said, too, that the public does not fully comprehend the great difference between different grades of competency in engineering. The public is too much inclined to put all engineers into two classes—the good and the bad. It does not realize that there are all grades between the extremes.

An excellent illustration of the attitude of the public toward this question is furnished by the legislation which has been proposed requiring all engineers to pass an examination before an official board and receive a license in order to have the privilege of practicing their profession. Talk with almost any layman on such proposed legislation and he will express the opinion offhand that it would be a good thing to have some such law so that the public would be protected from incompetent engineers. He has no appreciation of the flimsiness of any such barrier as a protection to the public.

We have so fully discussed this particular question in recent months that we do not need to consider it further here, except to point out that, from the standpoint of the public, there is real need that it should be assisted in the selection of competent engineers. It will be admitted, perhaps, that the banker or the capitalist engaged in large enterprises knows fairly well how to gage the ability of the engineers he is accustomed to employ, but that is only one limited aspect of the case. Take the engineers engaged in municipal work: How does the average city council know how to pick out the right engineer when it wants to build a bridge or system of waterworks or engage in a large scheme for road improvement? How shall governors and mayors and public boards know how to select the right engineers for the works they have in charge? Nor is this question limited to public works. The great bulk of the members of the profession engaged in mechanical engineering are in the employ of manufacturing concerns. How shall the superintendent pick out the right man for a chief draftsman? How shall the president find the man he needs for a superintendent? How shall the board of directors get the right man for the executive head of their concern? Upon such selections as these the financial success of many a concern will directly depend. But in how many cases is a certain man selected for an office simply because they do not know where to find a betted one?

When one stops to think of it, is there any commodity of commerce of such great value which is bought and sold by such crude and imperfect methods as is high-class professional and executive ability? There are recognized exchanges for buying and selling cotton and grain and metals and stocks. There are even exchanges for buying and selling the ordinary grades of labor; but when it comes to the highest class of professional service, on which so much depends, the buying and selling is done in a manner which leaves everything to be desired.

Let us take an actual example: Here is a mechanical engineer who has been for nearly half his lifetime in one position, having responsible charge of a certain class of work. He has attended strictly to business, but his work has been technical rather than executive and he has made no wide circle of acquaintances. Some business change occurs. Perhaps the controlling interest in the company changes hands. The works may be closed, or operated under a different system. The new owners have no use for his services. After 20 years of steady work he is thrown out of a position and he has little more idea how to find another one than if he were newly landed on earth after a journey from Mars. Further, and what is one of the most unfortunate features of the whole situation, a man cannot offer his own services for sale without immediately depreciating their market value by 50% at least. We may say this ought not be so, but we must recognize the existent fact. The mere statement that a man is out of a job and is asking for another always counts against him.

Take another illustration and a very common one: A man is engaged in a steady position but at work which he knows to be much below his capacity to perform and at a salary much less than he feels he would be worth in a more responsible position. How is such a man to find the opening that will place him where he wants

to be? In some cases, it is true, a man is fortunate enough to have employers or superiors who place the obligations of brotherly kindness above mere mercenary considerations and who are willing that a man should make an effort to better himself without imperiling his present position; but this is far from being always the case.

It may be said, in reply, that there are certain engineering employment agencies carried on by private enterprise which make a business of registering engineers who are open to offers of positions and who, with more or less industry, canvass possible employers. It may be admitted that these concerns do, after a fashion, serve as exchanges whereby the buyer and seller of certain classes of engineering work are brought together and enabled to do business. But many a man is loath to place his honor and his professional reputation in the custody of such organizations. Further, these concerns deal only with positions in which salaried men are involved. No solution to this problem can be considered complete which does not deal with the employment of engineers for public work, etc.

We wonder if many engineers have not at some time or other in their lives felt the need of some organization of high standing which could offer their services in the market without in any way lowering their own self-respect or lessening their market value. We do not believe any organization carried on as a private enterprise can meet this need, no matter how well managed or by whom conducted.

At various times in the history of Engineering News, the project has been canvassed of organizing in connection with this journal some such high-class exchange for professional services as is here proposed; but it is our belief that this is not a field in which private enterprises alone can do the best work. It is our belief that this work should be undertaken by the organized engineering societies of the country, and that it is the most important responsibility which now lies before them.

It is true that in a small way a number of engineering societies have already undertaken something in the way of an employment exchange. The American Society of Mechanical Engineers, for example, has for many years published at frequent intervals a bulletin containing a list of its members who are open to offers of new positions, together with a list of employers desiring engineers. In numerous other societies the Secretary's office has become more or less of a meeting ground for the members out of work and those looking for engineers.

The criticism we would make upon such work it that, while it is good as far as it goes, it falls far short of what ought to be done to put the buying and selling of high-grade engineering services on a dignified and proper basis. Instead of being a mere trifling side issue, it should be a fully organized and important department of every engineering society, and it should be conducted on a business basis.

Let us explain a little more fully what we have in mind: Suppose in the American Society of Mechanical Engineers, for example, there were a complete register including every member of the Society open to offers of a position, or to engineering work of any sort, in a consulting or other capacity, and stating concerning each man all the information that an employer or a client would desire to know. Such a list should, of course, be fully classified. All the different grades of work would be included so that the Society could satisfy applications either from the directors of a manufacturing concern in search of the right man for an executive head, or, at the other extreme, from concerns having openings for student members just graduating from college.

It is recognized, of course, that, before any concern selects an important executive officer, personal interviews will be had and thorough investigation of the man's past record will be made. The Society employment exchange would not recommend one man or another, but it would place in the hands of a concern in search of a vice-president, a superintendent, or a chief draftsman the names of three men or eight men or twenty men who would be eligible candidates for the position. It would show for each of these candidates what their entire experience and professional record had been. It would give the names of the men best qualified from personal acquaintance to speak as to the ability and character of each candidate suggested.

We believe that this service, if conducted as it might be conducted, would render greater benefits to the engineering profession and to the public which employs engineers than any other work in which the engineering societies of the United States have ever engaged. Of course, there would be difficulties in the conduct of any such organization. There are difficulties in accomplishing any useful and important task. There would be room, of course, for favoritism to creep in and for the Society to be made a tool to advance the interests of a certain few who were on the inside, with respect particularly to the recommendation of men for the highest positions.

It does not seem to us, however, that this is a strong argument against the undertaking of any such work. When the essential principle of professional work is honorable adherence to fair and impartial standards, we cannot believe that it is impossible for the organizations representing the engineering societies of the United States to carry out such an important trust in an honorable and impartial manner. If any of the societies are not now organized so that they are truly representative of the membership at large and so that the governing body can be trusted with large responsibilities by the membership, then reorganization is needed in any event.

Of course the argument will be brought forward that there would be dissatisfaction with a Society on the part of certain of its members who would fail to get positions and who might even have their present positions jeopardized, because it would be found possible to provide better men in their places. But failure to benefit such men is no reason why a Society should not do what it can to benefit its abler members. The fact must be faced that, with all the care taken in the selection of men for membership in the national societies, there is included in the membership of all of them a certain proportion of men of low grade. Of course, a Society cannot, in justice to its reputation, assist to place such men in positions where they are likely to bring discredit upon the profession. Nor would it be likely to under the plan we have suggested above, under which those desiring to employ engineers would be simply given a list of eligibles, with their qualifications, experience and references and the employer would make his own selection.

It is worth while to emphasize the fact even farther that the public needs this service from the engineering organizations as much as, if not more than, the profession itself needs it. Millions of public funds to-day are being wastefully expended because of the failure of the public to place high-grade experts in charge of the technical departments of public work. This is realized by very many intelligent citizens, but the difficulty they experience is in distinguishing the real expert from the man who poses as one.

If the engineering societies would each create an organization and make known their ability to furnish a list of high-class experts available for any class of engineering work, we believe their services would be in demand by city councils, by mayors, by governors and heads of state departments and even by many departments of the federal government, besides the demand from private business concerns.

Such a work by the societies would supplement and systematize the work which is now being done by many engineers, by the deans of engineering schools, by the heads of important engineering firms. At present when a man wants an engineer for an important piece of work and does not know where to find him, he writes letters to half a dozen people or firms who he conceives might know of such a man. All these people, as a rule, take time from their regular work to answer these queries to the best of their ability, knowing that they themselves may need aid in a similar search at any time. At the same time the engineer who is out of a position, or who is in a position and wants a better one, is writing twenty letters to people he knows who might suggest where what he wants can be obtained.

Such monumental inefficiency in connection with the buying and selling of engineering work is a disgrace to the engineering profession; but the individual engineer is powerless to help himself and can do very little to aid others.

Only through the organizations representative of the engineering profession can a systematic method be established for bringing the competent engineer into touch with the employer who desires first-class professional service and is willing to pay for it.

The four great national engineering societies have on their rolls over 21,000 members, who contribute annually some $300,000 for their support. These societies have the standing and reputation and public prestige to undertake such a work as we have proposed and make it a success. We repeat that it is the most important responsibility which is now before them.

LETTERS TO THE EDITOR

The Pressure of Wet Concrete Against Forms.

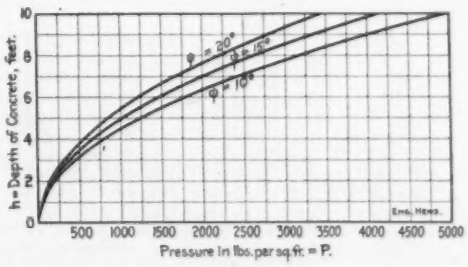
Sir: In order to ascertain the pressure of wet concrete against the forms in which it is placed, I have made a number of experiments, as a result of which I have decided that when mixed dry its action is the same as moist earth, but when wet or "sloppy" it develops a hydrostatic pressure. This pressure may be expressed by the formula

$$P = \frac{w\,h^2}{2}\left(\frac{1-\sin\phi}{1+\sin\phi}\right)$$

where

P = the resultant pressure in lbs. per sq. ft. acting at point ⅓ of the height of the concrete above the bottom of the form.
w = the weight in lbs. of concrete per cu. ft.; in wet mixtures say 140 lbs.
h = the depth in ft. of concrete poured in one continuous operation.
ϕ = the angle of repose of the wet concrete, varying from 10° to 20° according to the amount of water used in the mix.

I have plotted the values of P on the accompanying diagram, with depths of concrete up to



Pressure of Wet Concrete Against Forms with Varying Degree of Angle of Repose.

10 ft. and values of ϕ of 10°, 15° and 20°. The proper degree of the angle of repose must be determined by experiment.

S. Tomomatsu,
Building Department, Kure Naval Station.
July 2, 1911, Kure, Japan.

[In past numbers of Engineering News, various other methods of determining this pressure of wet concrete have been published, as follows: Sept. 9, 1909, p. 288; June 30, 1910, p. 748; July 18, 1910, p. 103.

It should be noted that the three values of ϕ in the accompanying diagram give the same results for P as though a straight hydrostatic pressure of 99, 83 and 68 lbs. were used instead of 140 lbs. with angle of repose of 10°, 15° and 20°, respectively.—Ed.]

A West-Side Freight-Terminal Plan for New York City.

Sir: In your criticism of my letter of July 17, printed in your issue of Aug. 3, 1911, on maintaining the freight tracks of the New York Central in New York City at the street level and using an elevated structure on West St. for street traffic, you say that unless combined with side-

New York City Charter Meddling.

While a rapidly increasing number of American cities, particularly in the western part of the country, are achieving a large and almost absolute measure of home rule in charter making, the great City of New York is still at the mercy of politicians at Albany who are threatening to enact a new charter for the metropolis. We shall not take time and space to go into the details of this latest exhibit of total disregard of the wishes of New York City and complete ignoring of the large amount of earnest and thoughtful work which has been put upon charter amendments by many experts in charter making and in municipal government during the last five or ten years. All that it seems necessary to say here is that, so far as we can gather, the proposed new charter deserves little but condemnation. We understand that hearings upon it will be given during the present legislative recess, the hearings to begin on Aug. 21. Although that is the time of the year when a large percentage of those competent to speak upon the subject are always out of the city, it is nevertheless to be hoped that the opposition to the new charter will be so strong and so cogent that when the legislature reconvenes to conclude its special session it will abandon this attempt to impose an ill-considered charter on New York City. If the legislature persists then we hope Mayor Gaynor will realize that it is his duty to veto the bill, even though rightly or wrongly it has become known as the "Gaynor Charter." If the bill does go by Mayor Gaynor, there is good reason to hope that it will be killed by Governor Dix.

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It is generally agreed, we take it, that at least nine out of ten members of the profession are receiving less for their work than what can be considered a fair compensation, when the degree of responsibility, the uncertain tenure of the employment, the long period of training and experience required to attain a high position in the profession, and the income earned by successful men in other lines of work are all taken into account.

The exceptions to this rule—the engineers who are amassing a competence or wealth—are very largely the men who have given up the professional practice of engineering and taken up some line of business. It is often said that engineering is a poor business. There is, however, plenty of good and profitable business in connection with engineering work.

Certainly, this situation is not one to be approved. It will be admitted, of course, that the professional man in any line of work, if we except the modern surgeon and the corporation lawyer, does not expect to gain a fortune, as fortunes are rated nowadays, in purely professional work; but at least he ought to gain a comfortable living and a chance to save a competence for his family and his old age.

It need not be said that engineers are mercenary in holding that the work of their profession ought to be better paid. It is well understood that the public to-day pays scant honor to success, unless that success can be translated into terms of dollars and cents. The engineer wants a larger income not alone because of the income or because of what it will yield for himself and his family, but because he realizes that his position in the community in which he lives and the respect that he and his fellow-members of the profession can command is greatly reduced if he is compelled through meager salary or inadequate fees to live on a scale far below that of his neighbors. And what applies to the man in the higher ranks of the profession applies also to the younger men, —to the rank and file, clear down to the beginners. We find men doing work requiring expensive education, a high degree of skill and, more than all else, a high grade of honor and trustworthiness. We find men meeting all these requirements and yet receiving compensation which is too often below that of the skilled workman who is a member of a union.

We shall not attempt to discuss in detail the causes which have led the engineering profession into this situation further than to say that they are traceable in general to the reaction in higher education against the old-time training which led nowhere and to the widespread desire among well-to-do parents to fit their sons for the work of a profession rather than for a business career. Whatever the causes, they are beyond the power of the engineer to remove.

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It has been seriously proposed by some engineers to follow the example of the trade union and attempt to limit competition and fix a standard scale of wages for draftsmen, instrument men, etc.

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It is not often realized, we believe, how difficult is the task of the man who wishes to employ a competent engineer, and how much more difficult the task is than it was 25 years ago! Not because there are fewer competent engineers, by any means; but because engineering work covers a far wider range, and the profession has grown so large that engineers themselves are often at a loss to find the right man for a special task. It must be said, too, that the public does not fully comprehend the great difference between different grades of competency in engineering. The public is too much inclined to put all engineers into two classes—the good and the bad. It does not realize that there are all grades between the extremes.

An excellent illustration of the attitude of the public toward this question is furnished by the legislation which has been proposed requiring all engineers to pass an examination before an official board and receive a license in order to have the privilege of practicing their profession. Talk with almost any layman on such proposed legislation and he will express the opinion offhand that it would be a good thing to have some such law so that the public would be protected from incompetent engineers. He has no appreciation of the flimsiness of any such barrier as a protection to the public.

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to be? In some cases, it is true, a man is fortunate enough to have employers or superiors who place the obligations of brotherly kindness above mere mercenary considerations and who are willing that a man should make an effort to better himself without imperiling his present position; but this is far from being always the case.

It may be said, in reply, that there are certain engineering employment agencies carried on by private enterprise which make a business of registering engineers who are open to offers of positions and who, with more or less industry, canvass possible employers. It may be admitted that these concerns do, after a fashion, serve as exchanges whereby the buyer and seller of certain classes of engineering work are brought together and enabled to do business. But many a man is loath to place his honor and his professional reputation in the custody of such organizations. Further, these concerns deal only with positions in which salaried men are involved. No solution to this problem can be considered complete which does not deal with the employment of engineers for public work, etc.

We wonder if many engineers have not at some time or other in their lives felt the need of some organization of high standing which could offer their services in the market without in any way lowering their own self-respect or lessening their market value. We do not believe any organization carried on as a private enterprise can meet this need, no matter how well managed or by whom conducted.

At various times in the history of Engineering News, the project has been canvassed of organizing in connection with this journal some such high-class exchange for professional services as is here proposed; but it is our belief that this is not a field in which private enterprises alone can do the best work. It is our belief that this work should be undertaken by the organized engineering societies of the country, and that it is the most important responsibility which now lies before them.

It is true that in a small way a number of engineering societies have already undertaken something in the way of an employment exchange. The American Society of Mechanical Engineers, for example, has for many years published at frequent intervals a bulletin containing a list of its members who are open to offers of new positions, together with a list of employers desiring engineers. In numerous other societies the Secretary's office has become more or less of a meeting ground for the members out of work and those looking for engineers.

The criticism we would make upon such work it that, while it is good as far as it goes, it falls far short of what ought to be done to put the buying and selling of high-grade engineering services on a dignified and proper basis. Instead of being a mere trifling side issue, it should be a fully organized and important department of every engineering society, and it should be conducted on a business basis.

Let us explain a little more fully what we have in mind: Suppose in the American Society of Mechanical Engineers, for example, there were a complete register including every member of the Society open to offers of a position, or to engineering work of any sort, in a consulting or other capacity, and stating concerning each man all the information that an employer or a client would desire to know. Such a list should, of course, be fully classified. All the different grades of work would be included so that the Society could satisfy applications either from the directors of a manufacturing concern in search of the right man for an executive head, or, at the other extreme, from concerns having openings for student members just graduating from college.

It is recognized, of course, that, before any concern selects an important executive officer, personal interviews will be had and thorough investigation of the man's past record will be made. The Society employment exchange would not recommend one man or another, but it would place in the hands of a concern in search of a vice-president, a superintendent, or a chief draftsman the names of three men or eight men or twenty men who would be eligible candidates for the position. It would show for each of these candidates what their entire experience and professional record had been. It would give the names of the men best qualified from personal acquaintance to speak as to the ability and character of each candidate suggested.

We believe that this service, if conducted as it might be conducted, would render greater benefits to the engineering profession and to the public which employs engineers than any other work in which the engineering societies of the United States have ever engaged. Of course, there would be difficulties in the conduct of any such organization. There are difficulties in accomplishing any useful and important task. There would be room, of course, for favoritism to creep in and for the Society to be made a tool to advance the interests of a certain few who were on the inside, with respect particularly to the recommendation of men for the highest positions.

It does not seem to us, however, that this is a strong argument against the undertaking of any such work. When the essential principle of professional work is honorable adherence to fair and impartial standards, we cannot believe that it is impossible for the organizations representing the engineering societies of the United States to carry out such an important trust in an honorable and impartial manner. If any of the societies are not now organized so that they are truly representative of the membership at large and so that the governing body can be trusted with large responsibilities by the membership, then reorganization is needed in any event.

Of course the argument will be brought forward that there would be dissatisfaction with a Society on the part of certain of its members who would fail to get positions and who might even have their present positions jeopardized, because it would be found possible to provide better men in their places. But failure to benefit such men is no reason why a Society should not do what it can to benefit its abler members. The fact must be faced that, with all the care taken in the selection of men for membership in the national societies, there is included in the membership of all of them a certain proportion of men of low grade. Of course, a Society cannot, in justice to its reputation, assist to place such men in positions where they are likely to bring discredit upon the profession. Nor would it be likely to under the plan we have suggested above, under which those desiring to employ engineers would be simply given a list of eligibles, with their qualifications, experience and references and the employer would make his own selection.

It is worth while to emphasize the fact even farther that the public needs this service from the engineering organizations as much as, if not more than, the profession itself needs it. Millions of public funds to-day are being wastefully expended because of the failure of the public to place high-grade experts in charge of the technical departments of public work. This is realized by very many intelligent citizens, but the difficulty they experience is in distinguishing the real expert from the man who poses as one.

If the engineering societies would each create an organization and make known their ability to furnish a list of high-class experts available for any class of engineering work, we believe their services would be in demand by city councils, by mayors, by governors and heads of state departments and even by many departments of the federal government, besides the demand from private business concerns.

Such a work by the societies would supplement and systematize the work which is now being done by many engineers, by the deans of engineering schools, by the heads of important engineering firms. At present when a man wants an engineer for an important piece of work and does not know where to find him, he writes letters to half a dozen people or firms who he conceives might know of such a man. All these people, as a rule, take time from their regular work to answer these queries to the best of their ability, knowing that they themselves may need aid in a similar search at any time. At the same time the engineer who is out of a position, or who is in a position and wants a better one, is writing twenty letters to people he knows who might suggest where what he wants can be obtained.

Such monumental inefficiency in connection with the buying and selling of engineering work is a disgrace to the engineering profession; but the individual engineer is powerless to help himself and can do very little to aid others.

Only through the organizations representative of the engineering profession can a systematic method be established for bringing the competent engineer into touch with the employer who desires first-class professional service and is willing to pay for it.

The four great national engineering societies have on their rolls over 21,000 members, who contribute annually some $300,000 for their support. These societies have the standing and reputation and public prestige to undertake such a work as we have proposed and make it a success. We repeat that it is the most important responsibility which is now before them.

LETTERS TO THE EDITOR

The Pressure of Wet Concrete Against Forms.

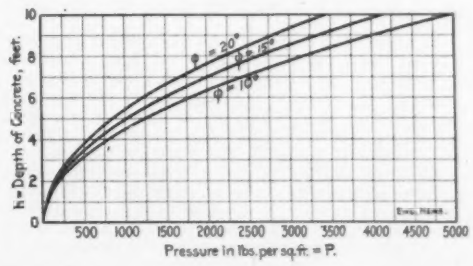
Sir: In order to ascertain the pressure of wet concrete against the forms in which it is placed, I have made a number of experiments, as a result of which I have decided that when mixed dry its action is the same as moist earth, but when wet or "sloppy" it develops a hydrostatic pressure. This pressure may be expressed by the formula

$$P = \frac{w\,h^2}{2}\left(\frac{1-\sin\phi}{1+\sin\phi}\right)$$

where

P = the resultant pressure in lbs. per sq. ft. acting at point ⅓ of the height of the concrete above the bottom of the form.
w = the weight in lbs. of concrete per cu. ft.; in wet mixtures say 140 lbs.
h = the depth in ft. of concrete poured in one continuous operation.
ϕ = the angle of repose of the wet concrete, varying from 10° to 20° according to the amount of water used in the mix.

I have plotted the values of P on the accompanying diagram, with depths of concrete up to



Pressure of Wet Concrete Against Forms with Varying Degree of Angle of Repose.

10 ft. and values of ϕ of 10°, 15° and 20°. The proper degree of the angle of repose must be determined by experiment.

S. Tomomatsu,
Building Department, Kure Naval Station.
July 2, 1911, Kure, Japan.

[In past numbers of Engineering News, various other methods of determining this pressure of wet concrete have been published, as follows: Sept. 9, 1909, p. 288; June 30, 1910, p. 748; July 18, 1910, p. 103.

It should be noted that the three values of ϕ in the accompanying diagram give the same results for P as though a straight hydrostatic pressure of 99, 83 and 68 lbs. were used instead of 140 lbs. with angle of repose of 10°, 15° and 20°, respectively.—Ed.]

A West-Side Freight-Terminal Plan for New York City.

Sir: In your criticism of my letter of July 17, printed in your issue of Aug. 3, 1911, on maintaining the freight tracks of the New York Central in New York City at the street level and using an elevated structure on West St. for street traffic, you say that unless combined with side-

walks for pedestrians it would necessitate a very extensive and costly construction. It was my intention that the elevated structure should be designed to accommodate all street traffic and while it would be an expensive structure, the same criticism is true of the design of any adequate freight terminal on Manhattan Island. [Our comment referred to combining the West St. elevated roadway with similar elevated ways throughout the busy districts of the city.—Ed.]

It is probably true that the railroads can deliver freight as cheap or even cheaper at their piers than if they had to place the cars on sidings on West St., but the cost that the merchant or manufacturer must reckon on is the cost of his goods delivered at the warehouse or factory; the congestion of trucking and long hauls by trucks increases this cost to a considerable extent.

It should also be borne in mind that, while a reduction of present costs would be an admirable thing, the prevention of future increase in costs is much more important. Business is done at a good profit in New York under present conditions, as evidenced by the large percentage of increase every ten years, but this growth of trade has been due to natural advantages rather than to an economical use of these advantages.

In considering the expense of making a freight terminal on Manhattan Island the continual shifting of business districts should receive a good deal of attention. For, while the continual encroachment of the retail trade on the residence districts and the movement uptown of the wholesale houses may be very profitable to the real estate operators, it is difficult to see how the city as a whole benefits, while the expense of these changes is a heavy burden on the community. The last few years have witnessed the removal of a number of wholesale houses from their former quarters downtown to the midtown loft zone for no very good economic reason except that there was no particular reason why they should stay where they were. If, however, New York had a comprehensive terminal system, adequate for present use and provision made for future extension, business districts in New York would exist for economic reasons and much better use be made of the land area available.

There is plenty of room below 14th St. and along the waterfront for all the important warehouse, wholesale and manufacturing business, to which the greater amount of freight is consigned, to take care of the development of this class of business for a great many years. Above 14th St. to 34th St. is an area well adapted for the large retail department stores, hotels, theatres and those factories whose business is closely related to the retail trade.

By arranging freight terminal facilities to meet present and future demands of trade, business centers can be established which will exist because of their economic relations to the terminal and more stable conditions will prevail; modern buildings will continue to replace older structures, but the trade centers remain the same.

The auto truck is already displacing the horse-drawn vehicle; it takes up less space and carries a greater load, so that, with the present congestion at terminal points relieved, less space need be provided for trucking purposes; it is with the object of eliminating trucking as far as possible and relieving the congestion of that which necessarily remains that the following terminal arrangement is outlined:

An elevated structure should be built over West St. and the Marginal Way from the New York Central's 60th St. yard to the Battery for all street traffic, with approaches every fifth street for access of trucks, and stairways at every street for pedestrians. Inclines parallel to the structure would be provided at all ferries, and entrances for trucks to piers at the second-floor level; the present street surface would be reserved for railroad tracks. This arrangement would provide better light and air for the street traffic where it is most needed, and at the same time render the track arrangement for the terminal yard more elastic, and give better connections to possible future under-river freight tubes or with freight subways in the city itself. The tracks would connect with the 60th St. and 30th St. yards of the New York Central and go as far south as the elevated structure. Car-float terminals would connect with the system in the neighborhood of Chambers St. Spur tracks would be run to all shipping piers, so that freight would be loaded directly from car to ship or vice versa, eliminating trucking and lighterage to a considerable extent for through freight. The most easterly track would be used as a siding, and the present sidewalk and enough of the present roadway reserved between approaches to the elevated structure to furnish room for a receiving and delivering platform with enough roadway for the passage of trucks, that is enough room for one truck to pass another which was backed up to the platform to receive or to deliver freight.

To prevent congestion of trucking the terminal siding should be divided up into sections, and freight shipped to the New York Terminal should be shipped by the consignor to the delivery section nearest to its final destination in the city; there is no reason why freight should not be shipped to certain specified sections along the terminal road in New York the same as if these sections were so many isolated towns along the railroad delivering the freight.

Buildings situated on West St. could have a track on the street level running from their elevator to the freight platform, on which they could have a car of the same dimensions as the elevator and thus receive or deliver goods about as handily as though a switch ran directly into the building; trucks would deliver to or receive goods from these buildings at the elevated street level.

Future demands for trackage might require that the space reserved for the freight platforms should be used for additional tracks, but such an increase in freight would warrant the purchase of land along the railway to furnish adequate delivery and receiving depots, while improvements in mechanical freight-handling devices will have still further reduced the proportion of goods trucked.

An important extension of this system would be a freight subway under Hudson St. from Vestry St. to Chambers St., connecting with the main terminal tracks under the approaches to the elevated street. This would be a short subway, but it should be wide enough for three tracks with freight platforms on each side, both outside tracks being used as sidings. The district is already largely used for storage warehouse purposes and should form the center for this business. Trucking would be largely done away with, as freight to or from ships could be loaded and delivered on terminal cars and railroad freight delivered directly.

With the financial and office-building district located at the lower end of the city it seems a logical development for the wholesale district to be located above along the line of passenger travel, with the warehouse district to the West at the freight terminal, the retail and amusement district above this, while the factory district would be stretched along the waterfront and terminal railroad, and the residence district lie north of all.

The criticism is often made of New York that conditions are never stable; strangers visiting the city at infrequent intervals find a different city on each occasion. The tendency has been to expand constantly northward along the middle of the island without developing to east and west of the center, although the street layout is such as to facilitate travel across town. Consequently there is a congestion of traffic north and south, while a great portion of the lower end of the city is practically undeveloped.

A freight terminal system might not cure all the ills of a great city, but it certainly seems as though it would help some.

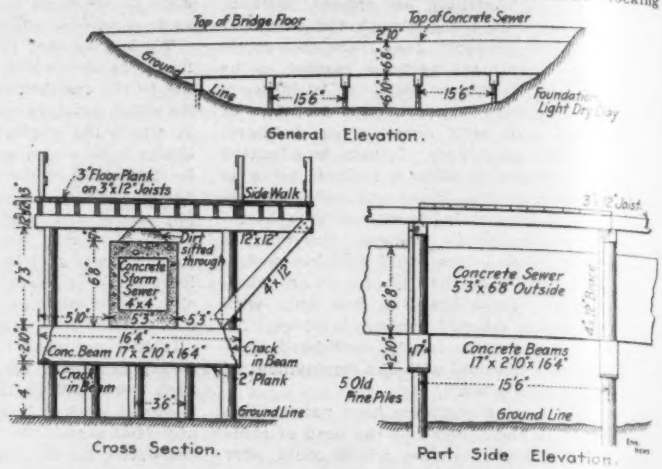
Chas. S. Wray.

Highland Mills, N. Y., Aug. 7, 1911.

A Curiosity in Concrete Sewer Construction.

Sir: Some time ago your paper made mention of a fearfully and wonderfully constructed arch as shown on the cover of a magazine. To show that the man who made that picture for the magazine need not be lonesome if he only knew where to look for company, I enclose a sketch of a storm sewer built in a western city. This sewer is built in the middle of a street, and is built of brick where it is underground. For years it was carried under this bridge through a timber box, but as the bridge is over a dry run it was decided to fill it in, as was done with other bridges on both sides over this same run. The concrete sewer was built so this could be done.

The question now is, how to underpin the sewer so that it will not break when the filling is done. The piles under the concrete beams are the old bridge piles and are badly decayed. That the bridge has sustained heavy traffic for nearly a year is a wonder. There may be some blocking over the sewer where the dirt has sifted through; I did not dig it out to ascertain. Even if there is, it cannot help matters much. Am unable to say that there is no reinforcing steel in this structure, but the indications are that there is not; I could not discover any where the beams are cracked.



CONCRETE SEWER BUILT UNDER TRESTLE; TRESTLE TO BE REPLACED BY EARTH FILL.

I did not dig it out to ascertain. Even if there is, it cannot help matters much. Am unable to say that there is no reinforcing steel in this structure, but the indications are that there is not; I could not discover any where the beams are cracked.

The Chicago, Milwaukee & St. Paul Ry. track crosses this same run on a pile trestle, and while looking after the filling of this trestle, this freak was discovered.

Adolph Yappen.
Assoc. M. Am. Soc. C. E.

Chicago, Ill., June 26, 1911.

A Locomotive for the Fearful and Wonderful Bridge.

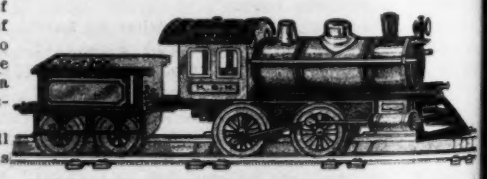
Sir: The accompanying illustrations of a "scientific and instructive" toy (taken from the list of premiums published by the "Youth's Companion") exhibits a striking mechanical paradox. To me it is interesting because it shows how completely (and disastrously) science may be divorced from the "art" of the illustrator. A locomotive of this design might be fit to run over the remarkable bridge spanning a recumbent Indian, which was illustrated in your issue of Dec. 9, 1909, p. 646.

Question: Which way will the wheels revolve?

Arthur H. Morse.

2305 Nelson Ave., Cincinnati, Ohio, June 24, 1911.

[This engine was doubtless designed by some "efficiency engineer" who desired to economize by making one piece of metal serve as both connecting rod and side rod. Perhaps there is a



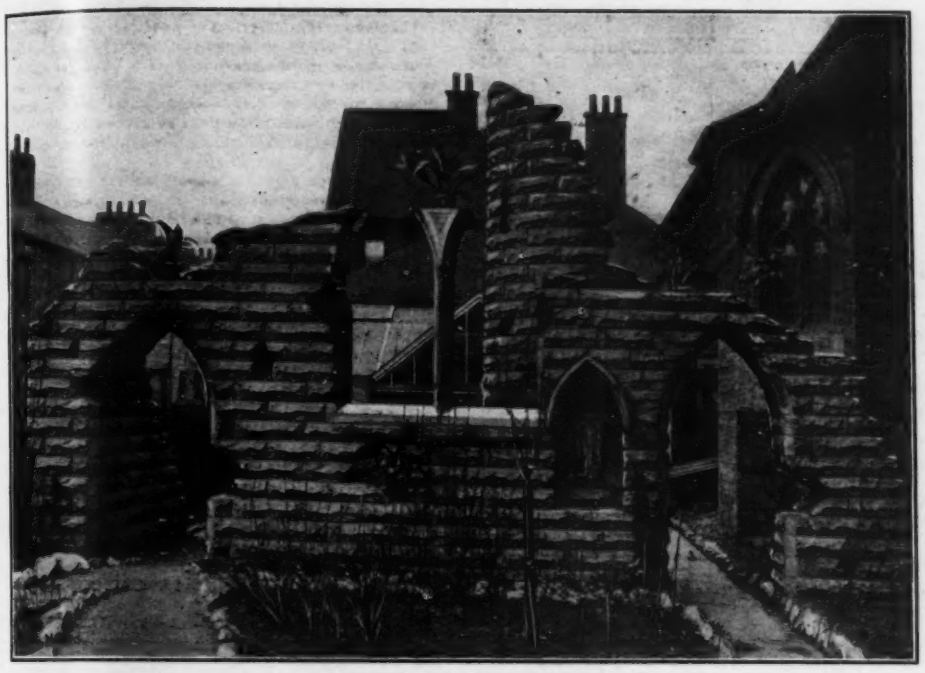
An Illustrator's Conception of the Connecting and Side-Rod System of a Toy Locomotive.

good chance that the machine might be made to run if a flexible connection were made with the tender and a fireman expert in circus balancing feats were provided. The locomotive's weight appears to be nearly evenly balanced over the forward pair of drivers, so that the fireman, by sliding backward and forward along the hand rail beside the boiler, might be able to keep the rear drivers just clear of the track. The engine, assuming it to be of the oscillating-cylinder type, would then run on its forward pair of wheels, while the rear pair revolved in the opposite direction. The enormous wheel flanges are probably designed to permit this mode of operation without danger of derailment. Another essential

to the movement would be a joint in the rear axle to provide for the different motions of the parallel (?) rods on opposite sides. The very English frame of the tender and the palpably American cowcatcher indicate that the illustrator had been cosmopolitan at least in his engineering studies.—Ed.]

The Last Word in Concrete Block Architecture.

According to "Concrete and Constructional Engineering," of London, the accompanying halftone is a view of an entrance to St. Peter's Church, South Bank, Norton-on-Tees, England, built of concrete blocks to represent old church



BRITISH RUINS MADE TO ORDER.

ruins. Comment is unnecessary, but we cannot refrain from thinking with what mirth and righteous superiority our English cousins would regard such a monstrosity were it to be found on this side the Atlantic.

The Utilization of the Wastes of a Blast Furnace; Manufacture of Portland Cement From Slag.*

By EDWARD M. HAGAR,†

Until the last decade, practically the only utilization of the wastes or by-products of a blast furnace was the use of a portion of the waste gases to raise the temperature of the incoming blast through heating the brick work in so-called hot stoves, and in some cases a small portion of the power value of the gases was obtained by burning them under boilers to generate steam for driving the blowing engines. At the present time the calorific value of the waste gases is being utilized directly in gas engines for blowing purposes and for generation of electric power, a considerable portion of the slag is used in the manufacture of Portland cement, and the flue dust, consisting of the finest ore and coke particles, is being collected and converted so as to be rechargeable into the furnaces. The aggregate saving or profits resulting from these three developments is a matter of millions of dollars per annum, and in a modern blast furnace plant, it would almost seem that pig iron was the by-product; and, indeed, the investment in the equipment to utilize these former wastes exceeds that in the blast furnace itself.

The writer, in his work, has come in contact with plants in operation, or under construction, of a capacity to produce 12,000,000 bbls. of Portland cement per annum from slag and limestone, using over 1,300,000 tons of slag in a year, these plants being driven entirely by electric current generated by gas engines directly from the waste blast-furnace gases, the power requirements being 40,000 HP. for 24 hours every working day.

By using the blast furnace gases directly in combustion engines, after suitable washing to remove the grit, the power obtained from a given amount of gas is equal to at least 2½ times that obtainable by burning the gas under boilers for generating steam for use in steam engines. A modern blast furnace of the usual size, with gas blowing engines, and gas engines driving electric generators, will provide sufficient gas to furnish 7,000 KW. electric power, in addition to driving its own blowing engines. This permits the most modern steel works, such as those at Gary, Indiana, to practically do away with the use of coal for power purposes, operating the rolling mills by electric power from the surplus gases. The United States Steel Corporation, of which the Universal Portland Cement Co. is a subsidiary, has already installed 250,000 HP. gas blowing and gas electric units which, it can easily be figured, displace or save the consumption of approximately a million tons of coal per annum.

With the modern high blast pressures, and the use of fine Missabe ore, the finest of the particles, together with the coke dust, are blown out through the top of the furnaces and are caught in the flues, dust catchers and gas washers. The iron ore in this dust amounts to fully 3% of the total ore charged, which aggregates the large amount of approximately 1¼ million tons per annum in this country. Until within a few years, this dust has been thrown away or used as filling, although containing about 40% metallic iron. For many years efforts were made to use this material by compressing it into briquettes, but the cost of the operation together with the fact that the briquettes disintegrated and the dust was again blown out led to an abandonment of the briquetting plants.

The first commercially successful method of utilizing the dust was discovered by passing the material through the cement kilns at South Chicago. Experiments showed that with the proper heat treatment the coke dust could be burned off and the iron ore conglomerated into nodules or nuggets averaging over 60% iron content. These nodules, when fed to the blast furnace, were easily and completely reduced. The fact that the sinter of the flue dust contains such a high percentage of iron and that all of the sinter is reduced, together with its physical shape assisting the steady movement of the charge downward in the blast furnace and thereby preventing so-called slips, makes the sinter more valuable per ton than any ore. It was necessary to devise mechanical means for preventing the accumulation of the sinter on the walls of the kiln. Plants have been in operation for some years using this process, with endless chains carrying scrapers constantly passing forward through the kiln, and cooled in water on their return outside of the kiln.

Recently other methods of utilizing dust have been devised which may prove successful commercially, and the indications are that within a short time the greater portion of this former waste will be prevented.

Comparing the pig iron production and Portland cement production of this country in figures of long tons, the percentage of Portland cement to pig iron in 1890 was 0.6%, in 1900 10.3%, and in 1910 47%. The continuation of any such relative growth would mean that before 1920 the tonnage of Portland cement would considerably exceed that of pig iron. I would hesitate, however, to predict that such would be the case.

In the manufacture of Portland cement from slag and limestone the molten slag flowing from the furnaces is granulated by a stream of water, loaded into cars and transported to the cement plants, where it is dried in rotary driers and receives the first grinding, it is then mixed, in automatic weighing machines, with the proper proportion of ground and dried calcite limestone. These are then ground together and burnt to a hard clinker at a temperature of nearly 3000° F. in rotary kilns, using pulverized coal for fuel. This clinker, after seasoning, is crushed and ground and mixed with a small percentage of gypsum to regulate the setting time. The cement is ground to such fineness that 96% passes through a sieve having 10,000 meshes, and 80% passes a sieve with 40,000 meshes to the square inch. It is then conveyed to the stock house for storage prior to shipment.

It is necessary to use as a flux in furnaces supplying slag for cement manufacture, a pure calcite limestone. The limestone burnt with the slag must also be a pure calcite stone. It is also essential that the ores be of a uniform and proper character. Inasmuch as Lake Superior ores are noted for their remarkable uniformity of analysis, the resultant slag obtained from the use of these ores and a pure calcite limestone is more uniform in its analysis than any form of natural clay deposit used in the manufacture of Portland cement, and the variation in the proportions of the two raw materials used in the manufacture of Portland cement from slag is less than those of any of the other materials mentioned above.

The rotary kiln commonly used ten years ago was 60 ft. long and 6 ft. in diameter. The length and diameter have gradually been increased until the modern kiln is 140 to 150 ft. long and 8 to 10 ft. in diameter, and there are a few even larger kilns in use. Kilns are usually set at an incline of ¾-in. to the foot. With the lining and contents the modern kiln weighs 150 tons, and in revolving upon two bearings presents interesting constructional features.

In the case of the plant at Buffington, Ind., using 26,000 HP., situated between South Chicago and Gary, Ind., electric power is supplied at 22,000 volts from the steel works at these points. Each piece of machinery is driven by its individual motor, supplied with alternating current at 440 volts. The high-tension line is connected through the cement plants, and the gas engines at these two steel works, 14 miles apart operate continually in parallel. This enables the cement plant to draw its power from either source, or from both sources at the same time, as may be desirable. It has happened that one of these works has supplied power to operate the cement plant and furnished additional power at the same time to the steel works at the other end of the line.

*Abstract of a paper presented before the Congress of Technology at the Massachusetts Institute of Technology, April 11, 1911.

†President, Universal Portland Cement Co., Chicago, Ill.

A System of Commercial Arbitration under which awards, it is said, will have "the force of a verdict by the Supreme Court of the State of New York" has been established by the Chamber of Commerce of the State of New York. It is expected that the system, which is open to residents of other states, will contribute materially to the relief of overburdened law courts as well as greatly facilitate the adjustment of difficulties. Mr. Charles L. Bernheimer is Chairman of the Committee on Arbitration which has brought about the adoption of the system—or the re-establishment in modified form of a system which was put in use many years ago and continued for a long period. The committee named has issued a pamphlet reviewing the history and present status of this arbitration system and giving by-laws and modes of procedure, with forms. This pamphlet can doubtless be obtained by addressing the Chamber of Commerce of the State of New York, whose headquarters are in New York City.

Standard Track Construction of the Great Indian Peninsular Ry. (India) Using Cast-Iron Ties.

The use of cast iron for ties would not be considered as desirable practice in railway track construction in this country, but such ties have been used extensively in India for many years, and continue to be used in modern construction.

A new standard pot-sleeper has been designed in order to carry the new 100-lb. rail. This is illustrated by Fig. 1. There are right-hand and left-hand pots, the former being placed under the right-hand rail as seen when looking in the direction of the traffic. The outer jaw of both types is tapered 1 in 45, and the narrower side is on the side towards which the traffic is going. The key is therefore driven in the same direction as the traffic. With the jaws being so tapered and the keys so driven, it follows that the pot under one rail

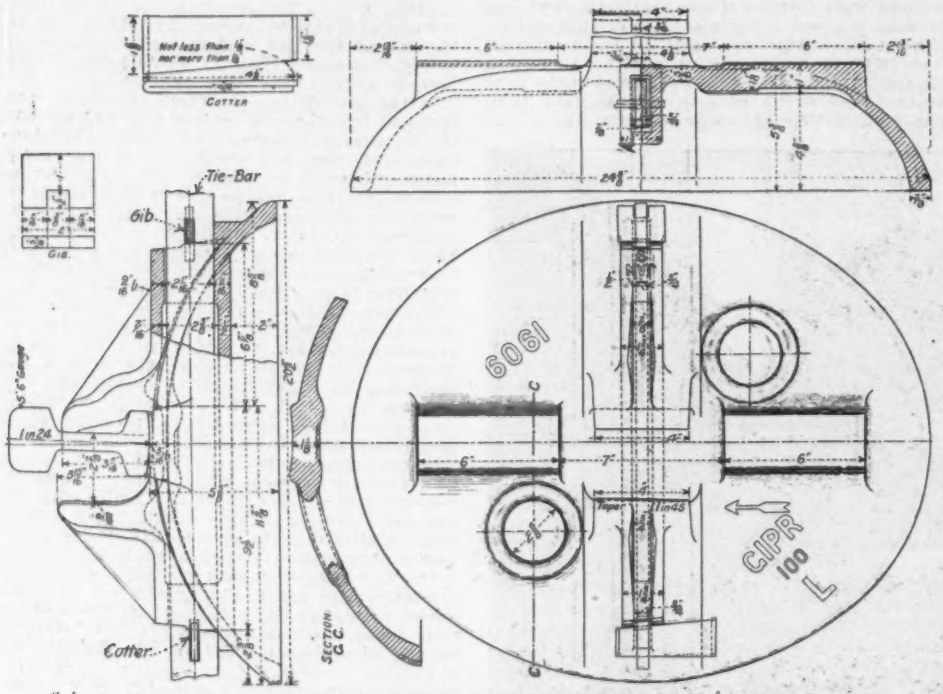


FIG. 1. CAST-IRON POT TIES FOR THE STANDARD TRACK OF THE GREAT INDIAN PENINSULAR RY.

(The two pots for each tie are connected by a tie-bar secured by gibs and cotters.)

The Great Indian Peninsular Ry., with a system of 3,000 miles, is one of the trunk lines using this type of track construction, and it has recently adopted a heavier track of this same type which will doubtless be of interest to many of our readers. The introduction of heavier locomotives made it necessary to strengthen the track, and on the recommendation of the consulting engineer, Mr. Robert White, M. Inst. C. E., it was decided to adopt as the standard a track with 100-lb. 36-ft. bull-headed rails carried upon cast-iron ties very similar to those previously used. For two short portions of the line, however, the rails are carried in cast-iron chairs on wooden ties, as noted later.

The railway has the Indian standard gage of 5 ft. 6 ins. Its former standard main track construction consisted of 82-lb. 36-ft. rails carried by cast-iron pots weighing 101 lbs. each., with 14 pairs of pots to a rail length. Each tie consists of two cast-iron oval bowls or pots, connected by a steel tie-bar which passes through slots in each bowl, and is secured by a gib on one side and a cotter on the other side of each bowl. Upon the top of the bowl are cast jaws like those of the chairs used to support bull-head rails on wooden ties. The rail rests against the inner jaw, and a key or hollow wedge (consisting of a steel spiral) is driven between the rail web and the outer jaw. The ballast is mainly trap rock (broken to 1-in. cubes) or screened river gravel. For the period 1872-1893, the tie renewals per annum averaged 0.57 to 0.80% for the cast-iron ties, and 4.57 to 6.14% for the wooden ties (creosoted pine).* The new track has 120-lb. pots and 13 pairs of pots to a rail length.

The following particulars of the track and of the machines used for boring and facing the wooden ties is taken from the May number of the "Railway Engineer" (London):

*Details of this type of track construction on several Indian railways will be found in two reports on metal ties, by E. E. R. Tratman, in Bulletins No. 4 and No. 9 of the Forestry Division, U. S. Department of Agriculture, Washington, D. C.

must differ from the pot under the other rail. They are therefore marked R or L and the arrow shows the direction the key is to be driven.

The pots are 24⅝ × 20½ ins. (oval), and 5⅜ ins. deep at the rail seats, of which there are two on each pot, 6 ins. long. They weigh 120 lbs. each. The two ballast-ramming holes are 2⅝ ins. diameter. The tie bars are 7 ft. 7⅝ ins. long, 2 ins. wide and ½-in.

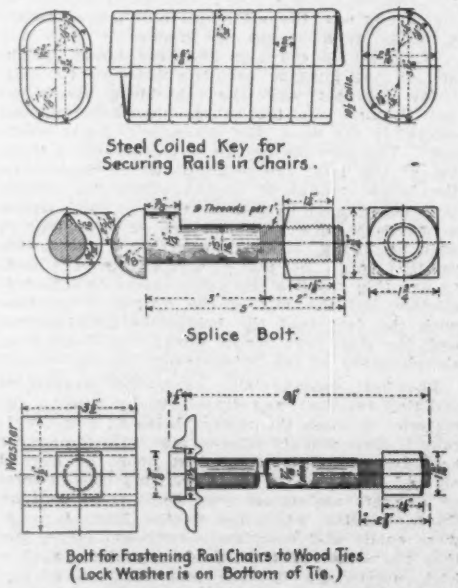

Steel Coiled Key for Securing Rails in Chairs.
Splice Bolt.
Washer
Bolt for Fastening Rail Chairs to Wood Ties
(Lock Washer is on Bottom of Tie.)

Fig. 2. Track Fastenings; Great Indian Peninsular Ry.

thick. The slots for the cotters are 1⅜ × ⅝-in., and are 13 3/16 ins. apart for each pot. The split cotters are 4½ ins. long on the shorter leg, 1⅝ ins. wide at the top, 1¼ ins. at the bottom, and 5/16-in. thick. There are 13 pairs of pots to each rail length.

Generally a steel coiled key (Fig. 2) is used. This is 7 3/16 ins. long, of ⅝ × 7/32-in. steel in 10½ coils. It is tapered and driven in the direction of the arrow marked on the pot.

The splice plates (flat, Ed.) are 18 ins. long and have four pear-shaped holes, 1 × 1 5/16 ins. The holes in the rail are 1½ ins. diameter, and the rails have a space of ¼-in. between them if laid in a mean temperature. If laid in a low winter temperature the space is increased to ⅝-in., but in a high summer temperature the space is only ⅛-in. The splice bolts (Fig. 2) are 5 ins. long under the head, of which 2 ins. are screwed with nine threads to the inch. The bolt is 15/16-in. diameter, and has an oval neck 1¼ × 15/16-in. and ⅞-in. deep. The nut is 1⅝ ins. square and 1¼ ins. deep.

Where wood ties are used, each rail length is carried on 14 ties 10 × 5 ins., and 10 ft. long, of untreated Australian jarrah. At the joints the ties are 2 ft. 1¾ ins. apart, those next the joint are 2 ft. 6 ins. apart, and the remainder are 2 ft. 7½ ins. apart.

The chair (Fig. 3) for the wood ties has a base 15½ × 7½ ins., with three longitudinal serrations on the outer side and two on the inner side. The chairs are fastened to the ties by two chair bolts (Fig. 2), one on each side. These are 8¾ ins. long over all and ⅞-in. diameter. [This type of chair fastening was devised by Sir James Inglis, M. Inst. C. E., of the Great Western Ry., England.]

The ties are adzed and bored and the chairs put on them at the company's yard at Kalyan, near Bombay. The combined adzing and boring machine was made for the railway by Thos. Robinson & Son, of Rochdale. The machine consists of a heavy cored cast table, on which is mounted a cross rail carrying both the adzing and boring heads. The spindles that carry the cutter blocks and cutters run in heavy self-oiling bronze bearings. The cutter blocks are shaped to give the serrations to suit the base of the chair (Fig. 3). They are capable of being adjusted horizontally to give wider centers between the chairs for curves.

In working, the tie is placed on the table and against the adjustable fence. The tie is drawn forward by dogs on two endless chains. When approaching the cutter blocks the pressure shoes outside the cutter blocks, and which are kept down by the counter-weights above them, come into operation; the side pressure shoe also is thrust inwardly by the counter-weight beneath it, and these keep the tie steady while it is passing under the adzing cutters.

After being adzed the tie is conveyed by the endless chains and left in position for boring. While being bored it is held by the top and side pressure shoes, which are hand-operated. When bored the tie is brought forward by an independent pair of feed chains.

The chairs being placed on the tie, and the chair bolts put in by hand, they are then secured by a hydraulic machine built by Fielding & Platt, Gloucester. The chairs are pressed down with a load of about 11 tons each, and while thus held upon the tie four rotating spindles screw up the two nuts for each chair. The spindles are driven by spiral gear from the horizontal pulley shaft. Each spindle is fitted with a socket corresponding to the nut, and the socket is driven by a spring slipping clutch, the power of which is regulated so that as soon as the required pressure has been applied to the nut the clutch will slip. As each spindle

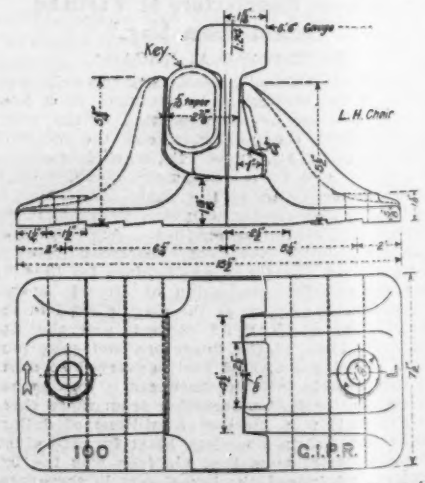


Fig. 3. Cast-Iron Chair (with Serrated Base) for Supporting Rails on Wood Ties; Great Indian Peninsular Ry.

has an independent clutch, it is clear that each of the nuts will be screwed up with the pre-determined pressure. The hydraulic cylinders are supplied by means of a small set of pumps and accumulator. The chairs are fastened and gaged in from two to three minutes each.

Notes From Engineering Schools.

DARTMOUTH COLLEGE.—By the reconstruction of the old gymnasium into a three-story building (with high basement), new quarters are being provided for the Thayer School of Civil Engineering. This will give about two and a-half times the floor space formerly occupied; there will be hydraulic, electrical, cement and materials laboratories, a shop, two large drawing-rooms with overhead lighting, a library, class rooms, an "alumni-memorial" room, and larger offices for the Director and the instructors. The hydraulic laboratory is being designed, with special features, in connection with a long series of tanks and weirs, so that it may be available for the constant use of students in immediate relation to daily class-room work.

Two Aviators Were Killed on Aug. 15, during an aviation meet at Grant Park, Chicago. W. R. Badger, an amateur, was flying with a Baldwin biplane machine, when he made a sudden descent terminating with an attempt at a sharp rise. The pressure on the supporting surfaces proved too much for their strength and the machine collapsed. The aviator was crushed by the impact of his engine on striking the ground. St. Croix Johnstone, a second amateur, was flying over Lake Michigan with a Bleriot monoplane, when a gasoline tank exploded wrecking the machine. The aviator was entangled in the wreckage after it struck the water and was drowned.

A 1,460 mile cross-country aeroplane trip was started on Aug. 14, from St. Louis to New York City by H. N. Atwood. The first day's course led to Chicago, 286 miles. The second day was used in reaching Elkhart, Ind., 101 miles. This second leg of the trip was made in 2 hrs. 16 mins., bringing the total flying time to 7 hrs. 59 mins.

The Water-Supply of New York City is still diminishing, owing to the lack of rainfall over the Croton drainage area. The city officials seem to be experiencing a change of heart regarding the desirability of an emergency supply, according to the following bulletin issued from the Mayor's office on August 15:

> The Mayor and Water Commissioner Thompson had a long consultation to-day about the Croton water-supply. It has sunk to 37,000,000,000 gals., making a more serious outlook than has existed heretofore. The subject of the conference was whether as a matter of prudence the city should not be connected with the Ten-Mile River as soon as possible. From that source 100,000,000 gals. a day can be derived. The Mayor and the Commissioner have had the matter under consideration for some time, and it is probable that they will conclude to connect the Croton River with the Ten-Mile River. The cost will be about $1,100,000. The conditions of drought all over the country are so serious that it is impossible to forecast whether the rains here in the fall will be sufficient to tide us over the winter.
>
> We understand that the authorization of the Board of Estimate would be required before a contract could be let for this work, but that once such permission was obtained Commissioner Thompson would soon be in position to invite bids. It has been estimated that the necessary construction work could be done in about four months.

A Water Shortage in Paris, France, is being experienced this summer, according to the following note in "The Engineer," of London:

> The water supply in Paris has fallen far short of requirements during July. It is true that these requirements have been abnormal, and that while Parisians are accustomed to leave the taps running all night during the hot weather, it is difficult to give them satisfaction even with the most perfect system of water distribution; but when Parisians assert that the huge sums of money they have placed at the disposal of the water department should put them beyond all possible reach of a water famine, the engineers have very little to say in defence. Although a great deal of money has been voted during the past year or two for bringing fresh supplies of water to the city, very little headway has been made with the new schemes. It was supposed that the water supply was sufficient for any ordinary emergency, but the municipal engineers could hardly have anticipated such a long spell of tropical heat, when the supply fell far short of the needs. During the month the daily consumption has been 290,000 cubic meters of spring water, 60,000 cubic meters of filtered water, and 70,000 cubic meters of river water, and the Parisians have been complaining that the river water has found its way into the domestic pipes. As the reservoirs have reached a very low level the water supply has been cut off every night, which has naturally given rise to a further grievance.
>
> This record of 320,000 cu. m. (84,700,000 gals.) per day, is equivalent to about 28 gals per capita per day. It is interesting also to note that the average per capita daily consumption of water in London in 1911 was 37.9 gals.

A Waterfront Fire at Antwerp, Belgium, Aug. 11, destroyed stores of cotton and saltpeter on the Queensland docks. The damage is estimated at $1,000,000.

A Powder Magazine in Costa Rica was destroyed Aug. 11, by an explosion which caused the death of several persons and injury of many others. Reports state that a number of buildings in San Jose, were wrecked.

A Boiler Explosion, Aug. 9, on the Rhine River Steamer "Gutenberg" near Rotterdam, Holland, killed two persons and seriously injured many others. Reports state that the boat's funnel and pieces of the boiler were thrown through the wall of a building on the river bank.

A Conflagration at Stamboul, Turkey, late in July, burned over an area of many square miles. The damage is estimated at $25,000,000 and reports state that 100,000 people were left without shelter. The extent of the fire is ascribed to incendiarism.

The 18-Hour Train from Chicago to New York on the Pennsylvania R. R., was derailed Aug. 13, at the western outskirts of Fort Wayne, Ind. Four trainmen were killed and 46 other persons were injured. The accident occurred at a turnout or cross-over switch which was being used to divert through trains from the main line during alterations of the track level. The train appears, from press reports, to have taken the switch at a speed of 60 mi. per hr. or more. It was being drawn by two locomotives, and reports state that a change of locomotives had been made soon after the train left Chicago, due to trouble with one of the engines. After leaving the rails at the switch the two locomotives struck the engine of a freight train on an adjacent track. This collision caused the fatalities to the engine crews. Four coaches left the track and rolled down the embankment, while the seven others remained on the rails. Many of the injured were in the dining car, which was the second car in the train.

An Explosion of Dynamite Aug. 11 destroyed several temporary buildings at the mouth of shaft No. 6 of the New York Aqueduct, near Cornwall-on-Hudson. Reports state that 1,100 lbs. of explosive were involved. One man was killed and one or two others injured. The contractor in charge of this section of the aqueduct work is the Mason, Hanger & Munsey Co.

The Mine Rescue Exhibition to be held in Pittsburg Oct 26 and 27, will be under the auspices of the Federal Bureau of Mines, American Red Cross Society, Pittsburg Coal Operators' Association and the United Mine Workers of America. This date has been set to enable President Taft to be present on the second day. The exhibition demonstrations have been planned to teach greater safety in mining, and will begin in the morning of Oct. 26 at the Bureau of Mines Experiment Station. This first day will be devoted to the interests of the mine operators, mine owners, mining engineers and superintendents. There will be an explosion of coal dust in the experiment gallery and tests of safety lamps in gas. A class of miners will be trained in the use of oxygen rescue helmets. In the afternoon of this day there will be an explosion in the experimental mine of the Bureau at Bruceton, twelve miles from Pittsburg. It is intended to carry out here all of the bad practices which are believed to cause explosions. On the second day, demonstrations will be given on Forbes Field, Pittsburg. A temporary steel gallery will be erected and the cause of recent great explosions will be shown, with spectacular effects. Members of the rescue corps of the Bureau of Mines equipped with oxygen helmets will demonstrate rescue work and first aid to the injured. Rescue teams from several mines will give exhibitions and there will be a parade of miners, about 30,000 of whom are expected to be present.

A New Club House for British Engineers is being built in Princes St., Westminster, London. The club, which was founded in 1864 and was familiarly known as "The Pick and Shovel," is now known as the Whitehall Club. The new building will have accommodation for over 500 members. Its cornerstone was laid late in July, 1911, by Mr. Alexander Siemens, President of the Institution of Civil Engineers. The ceremonies were participated in also by the presidents of the institutions of Mechanical and Electrical Engineers.

The Common Towel must now follow the common drinking cup into retirement from public places. The State Board of Health of Kansas has led the way by adopting the following rule:

> That the use of the common roller towel in hotels, railway trains, railway stations, public and private schools is prohibited from and after Sept. 1, 1911.
>
> No person or corporation shall place, furnish or keep in place in any hotel, railway train, railway station, public or private school, any towel for the common public use, and no person or corporation in charge or control of any such place shall permit in such place the use of the common towel.
>
> The term "common towel" as used herein shall be construed to mean roller towels and towels intended or available for common use by more than one person without being laundered after such use.

Panama Canal Excavation during July totaled 2,518,982 cu. yds., a daily output of 100,759 cu. yds. for the 25 working days. The amount of concrete laid during July was 129,727 cu. yds. and 621,180 cu. yds. of fill were placed in dams. The rainfall for the month was 6.87 ins.

The Population of Greater New York has passed the 5,000,000 mark, according to computations made by the City Health Department. The figures are estimated in accordance with the arithmetical method of forecasting the population in use by the U. S. Bureau of the Census. On this basis the population of New York City was 5,000,407 on Aug. 3, 1911, divided by boroughs as follows:

Manhattan	2,393,636
The Bronx	487,437
Brooklyn	1,716,852
Queens	312,630
Richmond	89,852
City of New York	5,000,407

The total population shows an increase of 53% during the 13 years which began on July 1, 1898, or about the time of consolidation with Brooklyn and other adjacent territory.

A Dam in the Desplaines River was partly destroyed Aug. 9 by citizens of Maywood, Ill., who claimed that it caused conditions dangerous to public health. The dam is owned by the North Shore Electric Co., is said to have raised the water 3 ft. recently, shutting off the flow in the stream below and causing the formation of numerous pools where mosquitoes bred in such quantities as to be a nuisance. The company had been notified to remove the dam or its upper part, but took no action in the matter, and the people therefore did the work themselves. According to report an opening 16 ft. long and 3 ft. deep was made. Following the lowering of the water above the dam quantities of dead fish accumulated upon the banks and a large force of men was required to gather these up, bury them and apply oil to the wet spots along the banks to prevent the breeding of mosquitoes. It is said that amicable arrangements have been made between the town authorities and the company, and that a gate may be installed to raise the water when necessary.

Fire Losses in the United States during 1911 bid fair to exceed any year in the history of the country except those in which the San Francisco and the Baltimore conflagrations occurred. The figures for the first six months of the year show a total loss of $129,691,750, as compared with $99,228,900 during the same period in 1910. The total losses in 1910 were $234,406,650 and if the present ratio of increase continues throughout the year, the 1911 losses will approach $300,000,000.

A Cantilever Crane of 28,600 ft.-tons capacity has been recently erected at the Hamburg shipyards of the Stettiner Vulcan in Germany. The crane is described as nearing completion in a note abstracted from "Der Eisenbau" in the July 1 issue of the "Zeitschrift des Vereines Deutscher Ingenieure." The crane is supported on three legs, of which two, 92 ft. apart, are in a line parallel to the sea wall. The third leg is 92 ft. from the line through the other two, and straddles over a railway track and a machine shop erected below the crane. The height of the structural support or tower is nearly 137 ft. The superstructure revolves on a circular roller track in the usual way. Its over-all length is about 293 ft., the two cantilever arms being respectively 182 and 111 ft. long. The upper chord is horizontal, while the lower chord slopes upward from the tower toward both ends.

The trolley tracks for the main trolley, instead of being on the top chord, lie about 13 ft. below it within the superstructure, at a height of 167½ ft. above the ground. The main trolley can lift a load

of 220 tons at a radius of 104 ft., or 110 tons at 169 ft. This is the maximum radius for the main trolley, but lighter loads can be handled at a somewhat greater radius by means of an auxiliary trolley which runs above the main hoist on separate rails on the top chord. This auxiliary trolley can run out no farther than the main trolley, but it carries a revolving jib with two hoisting hooks, one for loads of 22 tons at 21.3 ft. and the other for 5½ tons at 32.8 ft. Thus the maximum radius from the tower for a 5½-ton load is nearly 202 ft. The test load for the main trolley was 275 tons, at a radius of 104 ft., which gives the foot-ton capacity of 28,600. This is the largest crane of which we have information. Other large cantilever cranes were mentioned in our issue of March 30, 1911, p. 394.

Stagnation of the Electric Railway industry in England is admitted and explained in a paper by Mr. G. H. J. Hooghwinkel before the recent Congress of Tramways and Light Railways Association, at Edinburgh, printed in the London "Electrician" July 21. He maintains that absence of growth is not due to completed development but to the fact that they do not pay. This is attributed to the use of heavy double-decked cars and a rigid track construction. He champions the use of lighter cars with standing permitted on the platforms, a cheaper and more flexible track construction, light contact bows instead of trolley wheels, and trailers during the rush hours.

Personals.

Mr. Fred J. Macleod, a lawyer of Cambridge, Mass., has been appointed Chairman of the Massachusetts Railroad Commission.

Mr. H. H. Ober, formerly Trainmaster of the Chicago, Milwaukee & St. Paul Ry. at Wausau, Wis., has been appointed Superintendent of the Wisconsin Valley division of the same road.

Mr. P. H. Reeves, formerly Motive Power Inspector of the Baltimore & Ohio Southwestern Ry. at Cincinnati, Ohio, has been promoted to Master Mechanic of the same road at Chillicothe, Ohio.

Mr. M. C. Hutchins, of Ellenburg Center, N. Y., has resigned as Superintendent of Forest Fires for the First District of New York State to take charge of the forest fire-fighting work in Massachusetts.

Mr. H. E. Hale, Principal Assistant Engineer of the Missouri Pacific Ry., has been promoted to Engineer of Maintenance-of-Way of the Southern district of that railway, with headquarters at Little Rock, Ark.

Mr. J. B. Austin, Jr., formerly Engineer of Maintenance-of-Way of the Long Island R. R., at Jamaica, N. Y., has been appointed Superintendent of the same road, with headquarters at Long Island City, N. Y.

Mr. Walter H. Whiteside, M. Am. Soc. M. E., who resigned as President of the Allis-Chalmers Co., of Milwaukee, Wis., a short time ago, has been elected President of the Stevens-Duryea Co., of Chicopee Falls, Mass.

Mr. C. C. Coffee, formerly Superintendent of the Southern Ry., at Louisville, Ky., has been appointed Engineer of Maintenance-of-Way of the middle district of the same road. Mr. F. W. Brown, formerly Superintendent of Terminals at Birmingham, Ala., succeeds Mr. Coffee at Louisville.

Dr. C. O. Probst, Secretary of the State Board of Health of Ohio, and a member of that organization for 25 years, has tendered his resignation, to take effect Sept. 30. Dr. Probst is one of the best known public health officials of the country, and is a member and Past-President of the American Public Health Association, a member of the joint Ohio River Sanitary Commission, which includes representatives from the states of Ohio, Pennsylvania and West Virginia, and a leader in many other local and national public health movements. Dr. Probst is reported to have given as his reason for resigning "that under the present regime of the board, he was no longer permitted to direct the work along lines that seemed to him of most importance and for the best interest of the state."

Obituary.

Richard Hazen, Jun. Am. Soc. C. E., a brother of Mr. Allen Hazen, M. Am. Soc. C. E., died at Yonkers, N. Y., on Aug. 13, 1911, aged 24 years. He was a graduate of Thayer School, Dartmouth College, class of 1909, and was associated with the firm of Hazen & Whipple, Consulting Engineers, of New York City.

Gen. George W. Gordon, who died in Memphis, Tenn., on Aug. 9, while distinguished chiefly as a Confederate General and Member of Congress was at one time an engineer. He was born in Giles County, Tenn., and graduated from the Western Military Institute. He studied and practiced civil engineering until the outbreak of the Civil War. After the war he studied law and served for a time as one of the Railway Commission of his state.

Prof. Franklin Hiram King, formerly of the faculty of the University of Wisconsin, died at his home in Madison, Wis., on Aug. 6. He was born in Walworth County, Wis., on June 8, 1848. He graduated from the State Normal School of Wisconsin at Whitewater, and from a special course at Cornell University. From 1888 to 1901 he was Professor of Agricultural Physics at the University of Wisconsin, and from 1901 to 1904 Chief of the Division of Soil Management, Bureau of Soils, U. S. Department of Agriculture. Since 1904 he had been engaged in private practice as an expert in drainage and irrigation, soil management and ventilation of buildings.

William H. Jenks, a contractor of Brooklyn, N. Y., died on Aug. 5 of cerebral meningitis, following a sunstroke. He was 51 years old and the son of Elijah Jenks, an early New York contractor for river and harbor improvement work. At the death of Elijah Jenks the business was conducted by his brother Stephen H. Jenks under the firm name of Fearon & Jenks. Mr. William H. Jenks succeeded his uncle, after the latter's death, in 1886. The partnership was dissolved in 1895 but Mr. Jenks continued in river and harbor improvement contracting for himself. He was contractor for numerous piers, bulkheads and similar structures in and about New York City.

Charles S. Davidson, formerly Superintendent of the Hartford division of the New York, New Haven & Hartford R. R., died in Hartford, Conn., on Aug. 11. He was born in East Haven, Conn., in 1829. He entered the service of the New York, New Haven & Hartford R. R. when that railroad consisted merely of the line connecting the three named cities, in 1851. From 1853 to 1860 he was a locomotive engineer; from 1860 to 1862 a train conductor; from 1862 to 1872 Assistant Superintendent, during the Civil War, in special charge of transportation of troops and supplies. From 1872 to 1904 he was Superintendent of the Hartford division. Having completed more than half a century of active railway work with the same company, he lived to see that company expand to include practically all the railroad lines of New England.

Engineering Societies.

COMING MEETINGS.

SOUTH DAKOTA ENGINEERING SOCIETY.
Aug. 23-26. Annual meeting at Deadwood, S. Dak. Secy., R. G. Culbertson, Mitchell, S. Dak.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 29-Sept. 1. Annual convention at Chicago, Ill. Secy., W. O. Thompson, N. Y. C. Car Shops, East Buffalo, N. Y.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 12-15. Annual meeting at St. Paul, Minn. Secy., Clarence R. George, Houston, Tex.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12-15. Annual convention at Atlantic City, N. J. Secy., A. P. Dane, Boston & Maine R. R., Reading, Mass.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION.
Sept. 12-15. Annual meeting at St. Louis, Mo. Secy., W. E. Emery, Peoria, Ill.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION.
Sept. 13-15. Annual convention at Glenwood Springs, Colo. Secy., F. D. Morris, P. O. Box 1052. Colorado Springs, Colo.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 13-15. Annual convention at Gloucester, Mass. Secy., Willard Kent, Narragansett Pier, R. I.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 19-21. Annual convention at Spring Lake, N. J. Secy., N. T. Wilcox, Lowell, Mass.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 21-23. Annual meeting at Toronto, Ont. Secy., Jos W. Richards, Lehigh University, South Bethlehem, Pa.

MICHIGAN GAS ASSOCIATION.
Sept. 20-22. Annual meeting at Detroit, Mich. Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 25-27. Annual convention at Chicago, Ill. Secy., Preston S. Millar, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 26-29. Annual convention at Grand Rapids, Mich. Secy., A. P. Folwell, 239 West 39th St., New York City.

AMERICAN MINING CONGRESS.
Sept. 26-29. Annual session at Chicago, Ill. Secy., J. F. Callbreath, Denver, Colo.

LEAGUE OF AMERICAN MUNICIPALITIES.
Oct. 4-6. Annual convention at Atlanta, Ga. Secy., John MacVicar, Department of Streets, Des Moines, Iowa.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Annual convention at Atlantic City, N. J. Secy., H. C. Donecker, 29 West 39th St., New York City.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Oct. 10. Annual convention at Washington, D. C. Secy., Wm. H. Connolly, Washington, D. C.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 10. Annual convention at San Francisco, Cal., followed by trip to Japan. Secy., Joseph Struthers, 29 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 10-12. Annual convention at Colorado Springs, Colo. Secy., C. C. Rosenberg, Bethlehem, Pa.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Annual convention at St. Louis, Mo. Secy., C. A. Lichty, C. & N. W. Ry., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 18-20. Annual convention at St. Louis, Mo. Secy., A. B. Beadle, 29 West 39th St., New York City.

American Boiler Manufacturers' Association.

The 24th annual convention will be held in New Orleans, La.

Connecticut Society of Civil Engineers.

The midsummer meeting was held at Saybrook Point, Connecticut, Aug. 16. The new power-house of the Shore Line Electric Ry. Co. at Saybrook and the new rolling-lift highway bridge, now nearly completed, were inspected by the members.

American Mining Congress.

At the 14th annual session in Chicago, Sept. 26-29, the Committee on Workmen's Compensation will present a report recommending that state laws be enacted providing for an assessment of one cent per ton on coal production, the proceeds to be used for the benefit of those injured and the dependents of those killed in coal-mining accidents.

Roadmasters' and Maintenance-of-Way Association.

At the 29th annual convention, to be held at the Southern Hotel, in St. Louis, Sept. 12-15, the subjects of the committee reports to be considered are as follows: (1) Use of manganese steel for frog, switches and crossings; (2) Is it economy to use soft ties for track and at switches; (3) How to remedy soft spots in roadbed; (4) Motor cars for section work; (5) Concrete and steel ties; (6) Treated wood ties; (7) Emergency stock of tools; (8) New appliances for track and maintenance work.

National Conservation Congress.

The third annual session will be held at Kansas City, Sept. 25-27. The general objects of the congress are

to provide for discussions of the resources of the United States as the foundation for the prosperity of the people; to furnish definite information concerning the resources and their development, use and preservation; to afford an agency through which the people of the country may frame policies and principles affecting the conservation and utilization of their resources, to be put into effect by their respresentatives in state and federal governments.

The secretary is Thomas R. Shipp, Kansas City, Mo.

American Institute of Mining Engineers.

A committee of five members (appointed by the council of the institute) and the executive committee of the Mining and Metallurgical Society of America, met in joint session July 11 and unanimously adopted a resolution to the effect that some plan of affiliation of the two societies is desirable, each society to preserve its identity and separate organization. By a further resolution, the presidents and secretaries of the two societies were appointed a sub-committee to develop a plan on the above line to be submitted to the respective societies. At a meeting of this sub-committee, it was recommended to the councils of the respective societies that arrangements be made for joint meetings of the two societies whenever possible and that joint meetings of the local sections of the two societies be authorized and advised.

ENGINEERING LITERATURE

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REVIEWS.

A Naval Officer on Scientific Management.

Reviewed by AMASA TROWBRIDGE.*

COST KEEPING AND SCIENTIFIC MANAGEMENT.—By Holden A. Evans, Naval Constructor, U. S. Navy. New York and London: McGraw-Hill Book Co. Cloth; 6 × 9¼ ins.; pp. 252; 44 text figures. $3, net.

The aim of the author in preparing this book is two-fold. He endeavors to show the advantages of an elaborate cost system when applied to a large works and to also show how to manage a large plant by the adoption of Mr. F. W. Taylor's scheme of planning work and paying labor. Some fundamental principles are mentioned but the book is principally given up to the particular points involved in conducting a large plant. Because of his familiarity with shipyards, the author cites his examples from shipyard work.

The book begins with an argument for keeping as accurate costs as possible. As the author points out, such an argument is necessary to convince people who are prejudiced on account of the extra "non-productive" labor needed to keep the records, etc. The purpose of a cost system is then treated, the use of the cost-cards as follow-up cards being advocated. This requires a certain amount of duplication in the records, but the author contends that such duplication is worth while.

The actual planning of the cost system is then taken up. The elements involved are considered first. This is quite fully covered, particular attention being given to the matter of depreciation. The methods of charging off depreciation are so varied that an even more extended treatment of the subject might have been advisable. The distribution of indirect costs is next considered, distribution on the basis of direct-labor costs being advocated even though distribution on the basis of the machine-hour or machine-rate may be more accurate.

Next is taken up the question of forms for the various reports and records. The forms presented appear to be of a somewhat larger size than is absolutely necessary and it is probable that a smaller size would meet the requirements in most cases without unduly curtailing the writing space. Card sizes are better for such forms than the sizes specified and on account of convenience in filing and use should be chosen. In the matter of forms a person planning a cost system would do well to consult other books as well as this one. Some attention is given to the matter of indirect charges, that is, charges which cannot well be directly apportioned to the various orders. A scheme is outlined for classifying and applying these charges which the author has found to work well, but he leaves considerable to be supplied by the one who puts the scheme into practice.

The relation of overhead expense to cost of production is explained, and instances are cited showing how the percentage of overhead is kept low, even at the expense of efficiency. A high percentage of overhead expense, it is pointed out, may be one of the results of very efficient management.

"Methods of paying for labor" serves to bring out some important points regarding the various suggested methods, the conclusion arrived at being in favor of the Taylor differential piece-rate.

The author considers very thoroughly the question of works management based on the Taylor system. He starts off with the assumption that the works manager is not handicapped by having to use such machinery as he has in his plant and make the best he can of it. Most managers are up against this condition much of the time, for it is rarely possible to discard all the old machines and put in new ones, even assuming that it would pay to do so. He quotes Taylor's definition of management, i. e., "knowing exactly what you want men to do and then seeing that they do it in the best and cheapest way" as the foundation for his system. This is a good starting point. The reasons why his system is better than the old way of depending on "supervision" for everything are carefully gone over. The tendency of the foremen to do things as they always have done them and to employ mechanics to do work that should be done by laborers is noted. Stress is laid on the necessity for cooperation throughout the entire organization, if good results are to be obtained. In connection with this point even more emphasis might be used, cooperation being none too often the ruling spirit in a manufacturing or commercial organization. To gain information, the author suggests a visit to one's own factory as if one were a sort of supervising foreman. This is not a bad idea. It means getting an intimate knowledge of the conditions that actually exist in one's factory that could never be obtained through the superintendent, even if he knew the exact conditions.

The question of time and motion studies is treated at some length. The use of time studies is advocated for finding out where it pays to economize rather than trying to establish a "piece rate." It is also suggested that the manager who makes time studies will find he has neglected many things which should have received his attention.

The author states some "principles of scientific management which can be followed by a manager." He goes into detail so much that it would have been more appropriate to call them "particulars of scientific management." Here he advocates the employment of an "expert" when it is desired to install a modern method of production. That seems, from some viewpoints, to be a reasonable contention but, when it comes to convincing a board of directors that such an expert is necessary and will not introduce a lot of expensive red tape, a manager puts himself in a very delicate position. Most managers could best introduce modern methods by themselves becoming experts. The author gives many valuable hints for those managers who wish to take up this work in their own plants. He outlines the general plans to be pursued and goes into particulars on many points. Important among these are ways for saving the time of manager, superintendent and foremen. He advocates frequent, regular meetings and the omission of the sudden and inopportune summoning of department heads to conferences on points that could easily wait for a regular meeting.

The last part of the book takes up in detail the planning, arrangement, and methods of conducting machine shops and other shops. The examples given are for large shops and, while the ideas suggested are applicable to a small factory, it is only the large plant to which special attention is given. The system explained is based on Taylor's methods of planning the work completely before it is started. Not only metal-working but wood-working and tailor-shops are considered and examples showing cost-reduction by following the system are given.

A surprise greets the reader at the end of the book, for he finds an index, a most unusual circumstance in a book of this sort. This is an indication of the thorough manner in which Constructor Evans has prepared this valuable and timely addition to the literature of Scientific Management.

*Care of The Veeder Manufacturing Co., Hartford, Conn.

Cost Keeping.

COST-KEEPING FOR MANUFACTURING PLANTS.—By Sterling H. Bunnell, Ph. B., M. E.; M. Am. Soc. M. E., Assoc. M. Am. Gas Inst. New York: D. Appleton & Co. Cloth; 6 × 9¼ ins.; pp. 232; 37 figures in text. $3, net.

Mr. Bunnell has proceeded, in writing this book, on the assumption that it is a proper function of a mechanical engineer interested in manufacturing work to advise an accountant of some things about cost keeping which have been ordinarily just beyond the scope of an accountant's experience in the past. To that end he has shown what he believes has proven a successful way of recording the factors which enter the manufacturing outlay—a way in accord with the accepted principles of accounting, on the one hand, and, on the other, allowing an intelligent scrutiny of the cost of shop processes so that need for improvement may be recognized.

The author approaches his task by a brief summary of modern corporate organization, of financing and of accounting for funds received, receivable, spent, and payable. There are some points about this introduction which conservative operators may not entirely accept, except as the dream of promoters; these statements for instance:

> . . . . the usual arrangement for financing an enterprise provides that holders of bonds receive a fixed and small rate of interest, and have the maximum of security for their principal; preferred stock receives more, and may be less secure as to principal; and the common stock gets all there is left of earnings, sometimes running into hundreds per cent., but takes its chance of disappearing if the plant is closed out for the benefit of bonds and preferred, so that earning power [franchises, rights or fictitious accounts represent not property, but earning power] ceases and "rights" lose their value.

The necessity of cost accounting is briefly but very forcibly stated together with an analysis of the elements of "material," direct and indirect labor and unassignable expense, which have to be studied.

The author exhibits a set of forms by which the cost figures are reported from the shop and explains the steps necessary to operate such a reporting system. He claims for the recommended system great simplicity, directness and comparatively small expense.

One of the most interesting, and we should think helpful, parts of the book relates to a method for properly apportioning the burden of general shop ("overhead") expenses, other than labor, material and sundries, on the various products. In brief, the burden is assessed on the total number of machine hours in proportion to floor space, horsepower, repairs, depreciation, etc., and account is rendered of the various machine hours expended on each order. This does not prove to be the complication at first evident as the class and duration of machine hours is necessarily gleaned from material and labor reports.

The whole subject, though treating in detail only one branch of industrial accounting, gives enough information about its relation to accounting as a whole, so that its position appears in proper perspective.

An Analysis of Four Books on Engineering Contracts and Specifications.

By JEROME COCHRAN.*

The following analysis of four prominent works on engineering contracts and specifications by Johnson, Haupt, Waddell and Wait, and Fowler has been prepared with a view of showing the wide variation that exists in these works and at the same time giving an idea of the exact contents of each as an aid to those contemplating the purchase of any of these works. The table accompanying this article is the outgrowth of the writer's own need in knowing exactly where to look up certain contracts and specifications and the relative importance of same according to different authors. The titles of some of the specifications found in these works do not indicate the exact nature of the contents, and the classification has been made possible only after a diligent and prolonged search through these works, reading almost every page. It is, therefore, very easy to classify some of the pages incorrectly, but the table is believed to be substantially correct.

It is interesting to compare the nature of the specifications gathered together by these different writers and their opinions of what should appear in a book on this subject. With the exception of Waddell and Fowler, no attempt has been made to incorporate any original contracts or specifications. The great temptation is to merely collect a few sets of specifications written by others, classify them and the work is done. The writer firmly believes that the proper way to prepare a book on so comprehensive a subject as contracts and specifications is to gather up a dozen or more sets of contracts and specifications, study them carefully, and then prepare a set of general contracts and specifications, applicable to any class of work, leaving out local features entirely. This, of course, requires considerable time, but one is rewarded by the originality that is gained.

Haupt devotes 40 pages to contracts, while Waddell has almost three times as much space devoted to the same subject. The essentials of engineering contracts have been practically ignored by Johnson, Haupt and Fowler, while Waddell has treated the subject quite fully. Forms of contracts from practice have received about equal weight from Haupt, Waddell and Fowler, while Johnson devotes but three pages to such an important subject. At least 50 pages should be devoted to forms of contracts, not with a view to being copied by the student or young engineer, but so to direct him that he may be able to prepare intelligently contracts adapted to work on which he may be engaged. In this, as in all other parts of his work, he must study not only his own work but the methods of others.

Forms of advertisments or notices to bidders have received careful consideration by Haupt, Fowler and Johnson, while Waddell has omitted the subject. Of course proposal advertising is to be seen each week in the technical journals and in some of the daily papers, yet their preparation is not such an easy matter, and for this reason should be discussed just as much as the art of writing specifications, etc. The advertisement should be as short as possible to contain the necessary information, for advertising is expensive, and yet be sufficiently explicit as to the information required by persons desiring to bid, to prevent unnecessary delay.

General instructions to bidders have 24 pages devoted to them by Haupt and 11 pages by Johnson, while they are scattered throughout the government specifications given in Fowler's book. The general instructions to bidders should not be confused with the general conditions which also accompany specifications and which relates to and describes the work itself. These instructions may in one sense of the word be considered as the advertisement or notice to bidders, but containing more fully the necessary information required by bidders. Quite often many of these general instruction clauses for bidders appear in the advertisement for proposals, but should be sent out separately, as is generally done in government contracts.

General clauses in specifications are discussed quite fully in the 37 pages devoted to them by Johnson, while Waddell devotes 14 pages to them in his "Specifications for Rebuilding of Ten Bridges on the International and Great Northern R. R." The others have failed to discuss them at all. Of course, the general clauses are somewhat scattered throughout the different sets of specifications given in all four of the works, but one is obliged to spend considerable time in picking them out. The failure to properly segregate the general clauses appears to the writer to be a mistake, and is itself accountable for many omissions in specifications. In fact, the general clauses are the backbone to all specifications as they relate to the business portion of the contract, or which go to define the relations of the parties to the civil contract as a business proposition. Since the general clauses or conditions contain the requirements that are common to all kinds of specifications, they should certainly receive more attention than has been given to them by some authors.

Specific descriptive and complete specifications have been treated quite fully by Johnson and Haupt, while Waddell has confined himself principally to a set of specifications for light houses, general specifications for rebuilding several bridges and parts of a specification for riveted steel water pipe, less than 25 pages, altogether. One would judge from the title of the book that there would be a variety of specifications. Johnson devotes 425 pages to specifications and contracts from actual practice, there being about 75 sets of specifications, many of them being complete and accompanied by contracts. The majority of the specifications given by Haupt are those of the government and also those given by Fowler.

As to which is the best book for any particular individual will depend principally upon what he desires to know as the four works are entirely different in almost every respect except in the essentials of contract law. Haupt is very strong on harbor improvements, while Johnson devotes considerable space to pumping engines and power plant equipment. Waddell has 108 pages devoted to engineering contracts and 20 pages devoted to examples for practice in specification writing and an equal number to examples for practice in contract writing. Fowler has 42 pages devoted to the business of engineering and contracting and an original set of general specifications for steel roofs and buildings and eight forms of contracts. Haupt has 54 pages devoted to drawings and estimates not listed below and at the close of each chapter a set of questions relating to that chapter and a glossary of technical terms used throughout his book, which is very complete.

The total number of pages given under each column is the exact number of pages in the different books compared and not the sum of the separate figures given as several subjects have been omitted which do relate exactly to contracts and specifications in one sense of the word. The separate figures will, however, in most cases, total very closely to the total number of pages given.

As the writer has frequently been asked by students and young engineers to refer them to books from which they might acquire a better knowledge of the art of preparing specifications and contracts, the following list of books is given as valuable works on the various subjects indicated by the titles:

"Engineering Contracts and Specifications," by J. B. Johnson, C. E. Engineering News Publishing Co., New York City. $3.00.

"Engineering Specifications and Contracts," by Lewis M. Haupt, C. E. Henry Carey Baird & Co., publishers, Philadelphia, Pa. $3.00

"Specifications and Contracts," by Waddell and Wait, Engineering News Publishing Co., N. Y. City. $1.00.

"Law and Business of Engineering and Contracting," by Charles Evan Fowler, C. E. McGraw Publishing Co., N. Y. City. $2.50.

"Engineering and Architectural Jurisprudence, Law of Construction," by John Cassan Wait, M. C. E., John Wiley & Sons, N. Y. City, $6.00.

"Contracts in Engineering," by James Irwin Tucker, B. S., LL. B., McGraw-Hill Book Company, N. Y. City, $3.00.

"A Practical System for Writing Specifications for Buildings," by W. Frank Bower. Wm. T. Comstock, publisher, N. Y. City. $5.00 (out of print).

"Standard Specifications for Structural Steel, Timber, Concrete and Reinforced Concrete," by John C. Ostrup, C. E. McGraw-Hill Book Company, N. Y. C. $1.00.

"Specifications for Street Roadway Pavements," by S. Whinery. Engineering News Publishing Company, N. Y. City. $0.50.

It would be well if all of the above books might be found in every engineer's office; but if the expense prevents that, the ambitious student and young engineer should at least make himself acquainted with their contents. These works will also be found of great value to the enterprising builder.

ANALYSIS OF FOUR BOOKS ON ENGINEERING CONTRACTS AND SPECIFICATIONS.

	Number of pages.			
	Johnson.	Haupt.	Waddell & Wait.	Fowler.
1. ENGINEERING CONTRACTS OR AGREEMENTS.				
Essentials of Contract Law	..	8	..	11
Essentials of Engineering Contracts	..	..	16	..
Law of Engineering Contracts	55	..	39	..
Forms of Contracts from Practice	3	32	33	29
Examples for Practice in Contract Writing	..	..	20	..
Business of Engineering and Contracting	..	..	..	42
2. GENERAL CLAUSES IN SPECIFICATIONS AND ACCOMPANYING DOCUMENTS.				
The Advertisement or Notice to Bidders	7	12	..	10
General Instructions to Bidders	11	24	..	..
General Clauses in Specifications	37	2	14	..
3. SPECIFIC DESCRIPTIVE SPECIFICATIONS.				
Specification Writing in General	7	..	21	11
Excavations and Embankments	14	1	..	..
Plain and Reinforced Concrete	22	..	4	..
Stone & Brick Masonry.	23	11	..	..
Lumber Grading and Classification	15	..	..	..
Iron and Steel	7	..	6	6
Electric Light and Power Stations	12	..	..	..
Water Pipe	20	..	..	..
Sewers	13	..	..	..
Riveted Steel Water Pipe	7	..	3	..
Wooden Stave Pipe	2	..	..	..
Pumps & Water Wheels	7	..	..	..
Electrical Distribution Circuits	5	..	..	..
Boiler-Plate and Rivet-Steel	3	..	..	..
4. COMPLETE SPECIFICATIONS AND CONTRACTS.				
Harbor and River Improvements.				
Dredging, etc	..	6	..	8
Breakwaters	..	3	..	12
Canal Locks	..	6	..	..
Light Houses	..	12	11	..
Levees	2	..	..	..
Municipal Works.				
Sewers	..	14	..	..
Water Works.				
Pumping Engines	31	..	..	..
Water Tubular Boilers	8	..	..	..
Masonry Dam	34	6	..	..
Filter Gravel & Sand.	2	..	..	..
Reservoir	..	6	..	..
Roads, Streets & Pavements.				
Earth, Gravel & Macadam	..	9	..	7
Asphalt Pavements.	8	..	..	..
Brick Pavements.	5	..	..	..
Stone Pavements.	1	..	..	..
Wood-Block Pavement	..	..	..	..
Sidewalks, Curbs, etc.	4	..	..	..
5. STEAM AND ELECTRIC RAILWAYS.				
Steam Railroad Construction.				
Graduation	4	6	..	..
Track Laying	..	11	..	..
Cross-Ties	9	1	..	..
Rails	3	2	..	..
Steam Railroad Equipment.				
Freight and Passenger Locomotives	..	4	..	..
Tank, Box, Stock, Butter and Egg, and Gondola Cars	..	15	..	..

*Designing Engineer, Trussed Concrete Steel Co., Detroit, Mich.

	Number of pages. Johnson.	Haupt.	Waddell & Fowler.	Wait.
Electric Railway Construction. Track & Overhead Work	11	..	..	..
Electric Railway Equipment. Electric Motors	3	..	..	..
Power Plant Equipment. Engine	5	..	..	..
Boilers	3	..	..	..
Condensers and Pumps	2	..	..	..
Economizers	2	..	..	..
Electric Generators	5	..	..	..
6. STEEL STRUCTURES. Steel Framework of Buildings	16	..	..	9
Steel Highway Bridges.	26	..	..	..
Steel Railroad Bridges.	29	11	..	..
Steel Stand-pipes	2	..	..	..
7. MASONRY STRUCTURES. Bridge Piers	..	8	..	..
Tunnels	..	3	..	..
8. TIMBER STRUCTURES. Pile and Trestle Bridges	5	7	..	..
9. ARCHITECTURAL. Engine House	24	..	..	..
College Building	..	14	..	..
Passenger Depot	..	16	..	..
Architect's Services	11	..	..	..
10. MISCELLANEOUS. Testing of Hydraulic Cements	4	..	..	..
	20	..	..	4
Total number of page	563	328	169	162
Net price	$3.00	$3.00	$1.00	$2.50
Date of copyright	1904	1900	1907	1909

A Manual of Railway Practice.

MANUAL OF THE AMERICAN RAILWAY ENGINEERING ASSOCIATION.—(Edition of 1911) Chicago, Ill.: The Association (962 Monadnock Block, E. H. Fritch, Secy.) Paper; 6 × 9 ins.; pp. 476; illustrated. $2.50, net. (Cloth, $3; half morocco, $3.50.)

One of the purposes of the American Railway Engineering Association is to effect improvement and uniformity in methods of work, and to crystallize matters of good practice into definite statements and recommendations. To this end, its committees work to a more or less prescribed program and with the distinct object of presenting definite matter of this kind in their reports, apart from matters of general discussion or information. The matter is subjected to the criticism and action of the membership as a whole. The Association, from its earliest days, has had in view the compilation of these definite recommendations and their publication in book form as a manual of good practice for the use of railway officers and employees, leaving the general matter of the reports and discussions as additional information to be consulted in the "Proceeding" by those directly interested. The first edition of the "Manual" was published in 1905, and the second in 1907, while supplementary matter has been given in bulletins issued at different times.

The third edition (1911) covers the revision of the matter at the annual meeting of March, 1911, each committee reviewing its own subject matter. There are 18 general subjects, which we may group as follows: (A) railway location, 12 pp.; (B) track construction and equipment, 130 pp.; (C) bridges, masonry and buildings, 90 pp.; (D) signaling, 38 pp.; (E) records and rules, 85 pp.; and (F) yards, terminals and water service, 60 pp. The book is intended for wide circulation among railway departments, officials and employees, and several railways already have ordered large numbers for distribution.

From the manner of its preparation the amount of space devoted to the several subjects is not always proportionate to their relative importance. It is to be understood also that the book does not assume to be a complete treatise upon the several subjects, but to give simply the results of the work of the committees in certain directions. We can perhaps best give an idea of the character of the "Manual" by referring to some of the principal subjects in its different departments.

The 12 pages on "Economics of Railway Location" deal with the questions of engine power and train resistance. "Roadway" (30 pp.) includes specifications for grading, requirements for steam shovels and steam shovel work, waterways and drainage, and the organization for grade reduction and track elevation work. "Ballast" (6 pp.) includes cross sections and specifications for material. "Ties" (6 pp.) includes specifications, and blank forms for records of tie renewals; with this may be mentioned, however, the section on "Wood Preservation" (14 pp.) which gives specifications for creosote oil and for treatment by various processes. The matter on "Rails" (28 pp.) consists mainly of a series of blank forms for reports of rail wear and broken rails; also specifications for a drop-test machine. Under the head of "Track" (32 pp.) there are notes on various matters relating to maintenance work, but the principal features are an analysis of turnouts and spiral curves (with tables of function of the ten-chord spiral).

In "Wooden Bridges and Trestles" (26 pp.) we have specifications for timber and workmanship, the requirements for pile driving, and a statement of the standard defects of structural timber. In "Iron and Steel Structures" (24 pp.) we have recommendations for contracting methods, bridge inspection, and classification of bridges as to their carrying capacity; also specifications for material and workmanship. "Masonry" (42 pp.) includes specifications for cement, stone masonry, and plain and reinforced concrete. "Buildings" (12 pp.) is relatively unimportant, giving general rules as to the design of small stations, engine houses and minor structures, with two pages relating to roof coverings. Under "Fences" (17 pp.) we find specifications for fencing; also notes on wire, gates, concrete posts, snow fences and snow removal. The part on "Signals and Interlocking" (40 pp.) has some matter on the location of signals, but 24 of its pages relate to specifications for wire and cable.

The section on "Records and Accounts" (77 pp.) is one of the most important, as it deals very comprehensively with a subject upon which there is very little literature. It presents a complete set of blank forms for bridge and bridge-inspection reports and records; and forms for work and material reports, estimates, material reports, time-books, engineers' estimates, etc.; also track charts and progress profiles, and records of right-of-way, title deeds and leases. "Rules and Organization" (9 pp.) is of less importance, being simply a revised form of general rules to employees in the maintenance-of-way department, such as are in use on most railways. "Water Service" (50 pp.) relates to water-supply, water softening and pumping, with a discussion of friction in pipe lines and water columns. The matter on "Yards and Terminals" (12 pp.) is not lengthy, but this also is important in dealing with subjects upon which very little has been written; it includes a series of general recommendations relating to the individual features of terminal plants and including also gravity switching and yard lighting.

McGRAW ELECTRIC RAILWAY MANUAL.—The Red Book of American Street Railway Investments. A Manual of the Securities, Traffic Statistics, Earnings, Officers, Directors, and Equipment of Street and Interurban Railways of the United States, Canada, Cuba and West Indies. Eighteenth Annual Number, 1911. Edited by Frederic Nicholas, Associate Editor of "Electric Railway Journal." New York: McGraw Publishing Co. Cloth; 9½ × 13 ins.; pp. 430; maps. $5, net.

The familiar "Red Book" of American street railway investments officially designated "American Street Railway Investments" appears this year with the new title "McGraw Electric Railway Manual."

The data shown are for the most part tabulated for the years 1908, 1909 and 1910. The greatest change seen in this volume over the issue of previous years is perhaps the aggregation of these data for states, groups of states and for the country. This is an interesting feature and one which will be appreciated by those who are more apt to have this book handy than a file of the "Electric Railway Journal" where the aggregate figures have before been published.

Street Pavements in Chicago.

STREET PAVEMENTS LAID IN THE CITY OF CHICAGO.—An Inquiry into Paving Materials, Methods and Results. Report prepared by the Chicago Bureau of Public Efficiency, 900 Masonic Temple, Chicago, Ill. June, 1911.

A good share of this report is a criticism of the specifications of the Association for Standardizing Paving Specifications which met in Chicago in February, 1910, and in New York in January, 1911. It will be remembered that the first of these conventions was called at the instance of the Mayor of Chicago and that the city officials of Chicago attending the convention were the dominating element. The specifications adopted at this convention and modified by the New York convention are the ones in force in Chicago.

It is claimed in this report that the method of procedure used at the New York convention, that of having the specifications prepared by committees in secret sessions, gives undue influence to private interests. As a specific case of this the report takes up the requirements of the preservative oil used in the manufacture of wood paving blocks. The New York convention specifications call for an oil having a specific gravity of not less than 1.10. It is claimed that coal tar oil having so high a specific gravity is made only in the Otto-Hoffman and Sement-Solvay patented processes. Instead of imposing a royalty on the process it is claimed that the gas companies are required to enter into an agreement to sell this by-product only to the German-American Coke & Gas Co., which in turn hands over the product to the Barrett Mfg. Co., both of which, it is claimed, are controlled by the American Coal Products Co. The Barrett Mfg. Co. is believed to sell only to wood preserving concerns allied with this same American Coal Products Co.

This report further states that not only is genuine creosote oil excluded by these specifications but that the results obtained by using the heavier and more expensive oil are inferior in every way to those with pure creosote oil. The exudation of a thick tarry substance from several Chicago wood-block pavements during the last two summers, which has caused much annoyance and many complaints, is largely laid to the use of this heavy oil, it being claimed that earlier pavements treated with pure creosote oil of a specific gravity of about 1.04, give no trouble in this respect.

Mr. Otto Klein, Chief Engineer for the Commissioner of Accounts, New York City, objected, on the floor of the convention, to these specifications on the ground that they might limit competition. He moved that the specifications be not adopted until further inquiry was made regarding the preservative oil; yet no one of those present seconded his motion.

The rest of this report takes up the necessity for more effective inspection of work, and recommendations regarding asphalt pavements. The claim is made that much money could be saved by adopting an asphalt surface designed to meet the kind of traffic in the particular street in which it is laid. The present method is a uniform pavement consisting of a 6-in. concrete base, a close binder of 2½ ins., and a wearing coat 2 ins. in thickness. For lighter traffic the report suggests a 4-in. base, a 1½-in. binder and a 1½-in. wearing coat. An estimated reduction of $0.40 per sq. yd. would result, or an annual saving of $200,000, if this pavement were adopted for light-traffic streets.

A memorial to the late Tom L. Johnson is a feature of the issue of July 21 of "The Public," published at the Ellsworth Bldg., Chicago.

Mr. Johnson was so prominent a figure in connection with engineering work for many years and had so wide a circle of friends and acquaintances among engineers that some of our readers may find it of interest to obtain a copy of the publication. It is an interesting review of a truly remarkable character.

Applied Electrochemistry.

APPLIED ELECTROCHEMISTRY.—By M. De Kay Thompson, Ph. D., Assistant Professor of Electrochemistry in the Massachusetts Institute of Technology. New York: The Macmillan Co. Cloth; 6 × 9 ins.; pp. 329; 137 illustrations in text. $2.10, net.

While this text-book of electrochemistry was evidently intended particularly for chemists or electrochemists it will be of great interest to engineers. Some sections (aggregating 65% of the text) describe technical developments—commonly called "applied electrochemistry." The rest of the subject matter relates to experimental and theoretical studies of the reactions involved, and the engineer, who has not studied physical chemistry and followed the developments of that branch of science, will be lost in a sea of unfamiliar terms.

The author takes up first electrochemical adjuncts of quantitative chemical determinations, very briefly touching the borderland of the large field of service made known by Provost Smith, of the University of Pennsylvania in his recent book.* Following this, is a section on electroplating operations, with various metals, as commercially worked. The chapter on the winning and refining of metals from aqueous solutions is also a "practical" treatment. However, when the ordinary engineering reader strikes Chapter V., on electrolytic reduction and oxidation, he will find need for collateral study and review. By "reduction" is meant (1) the loss of a positive electric charge of an ion, (2) the acquisition of a negative charge, (3) the direct removal of oxygen from a molecule. "Oxidation," however, has a more limited range of use.

Evidently on account of the importance and magnitude of the electrochemical industries depending on the electrolysis of alkali chlorides, the author considers a theoretical discussion of the reactions quite necessary. The various equilibrium constants are developed to show the computation of amounts of several compounds which may be expected to exist under the conditions of practice. Descriptions of commercial apparatus follow these discussions.

The theory of primary and storage batteries is well covered and accompanied by descriptions of commercial forms. A whole chapter of 12 pages is given to the new Edison nickel-iron storage cell.

The sections relating to electric furnaces and metallurgy are particularly good and sure to be appreciated by all readers of the book. After a brief classification of furnaces, the design is taken in hand, showing very largely methods of procedure disclosed in Hering's recent papers on walls and electrodes. Then follows short descriptions of processes for the production of calcium carbide, carborundum, "siloxicon," "alundum," silicon, graphite, carbon bisulphide, phosphorus, aluminum, sodium, potassium and calcium.

Preliminary to study of the electrometallurgy of iron and steel, is a brief outline of the older metallurgy. This greatly assists an appreciation of the matter on the several electric stack furnaces—Stassano's, Keller's, Héroult's and Grönwall's—for the production of pig iron and on various smaller furnaces for refining pig to special high-grade steels.

The author branches out into what we may call electric-discharge chemistry, taking up the fixation of atmospheric nitrogen and the formation of ozone. The section on the nitrogen industry is illuminating on the theoretical side and apparently complete and up to date in maeters of technique and commercial development. The same commendation cannot be extended to the section on ozone; most of the space is given over to a discussion of laboratory researches into the influence of surrounding conditions on the production of ozone—things like the interrelation of concentration, temperature, composition of gases admitted, energy, etc., etc. The weakness of the presentation lies in what the author calls "the technical production of ozone." The pieces of apparatus noted are only a few European types and no mention is made of most recent commercial development even in Europe. The considerable work of a practical nature done in this country has been completely overlooked. As a fact, there are three American systems, having a considerable commercial development and something should have been written about their successes and failures. Surely a professor in a great American technical school should know the status of such work in his own country better than this would indicate.

*"Electro-Analysis," by Edgar F. Smith; Blakiston Son & Co., Philadelphia. Reviewed in Eng. News, Lit. Sup., Dec. 12, 1907.

Wegmann's Dams Revised.

THE DESIGN AND CONSTRUCTION OF DAMS.—Including Masonry, Earth, Rock-Fill, Timber, and Steel Structures; also the Principal Types of Movable Dams. By Edward Wegmann, C. E., M. Am. Soc. C. E.; Author of "The Water-Supply of the City of New York, 1658-1895"; Consulting Engineer, Dept. of Water-Supply, Gas and Electricity, City of New York. Sixth edition, revised and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 9¼ × 12 ins.; pp. 529; 157 plates, 198 text figures and 24 tables. $6, net.

Wegmann's "Dams" is becoming one of those rare engineering works that needs and warrants a revised edition every few years. It so happens that the period between the fifth and the sixth (the latest) edition is only four years, which is only half the interval between the fourth and the fifth editions; ample evidence of the popularity of the work. The revision of this last edition involves an increase of pages from 421 to 529, of full-page plates from 133 to 157 and of figures in text from 120 to 198, over the next previous edition. This increase is largely made in two new chapters, one on "Cofferdams" and one on "Overflow Weirs," but considerable additional material is devoted to bringing up to date old descriptions of works under construction and to new descriptions of structures started since the last edition was published.

The chapter on "Cofferdams" notes first the various types of cofferdams and following that describes in detail a number of typical constructions, including such recent works as the pneumatic caisson cofferdam for the Hauserlake Dam and the sheet pile cylinder dam around the wreck of the "Maine" in Havana harbor. The advisability of including this latter in a permanent work is debatable, especially as at present it is impossible to state with any degree of certainty the probability of its success or the problems of its construction. The chapter on "Overflow Weirs" is mostly of a descriptive nature, using the Indian and U. S. Reclamation Service weirs as examples of design. The methods of computation given in detail by Mr. W. G. Bligh in his books and articles in Engineering News are drawn from extensively.

The chapter on "Recent Dams" collects all of the latest examples of all kinds of dam construction, such as the raising of the Assuan Dam, the large masonry dams of the arid west, the Gatun Dam and several movable dams of the latest types. The author does not propose to be accused of a lack of completeness in his treatment, for he has provided in this latest edition two pages on beaver dams and tinker's dams.

UP-TO-DATE AIR-BRAKE CATECHISM.—By Robert H. Blackall, New York: The Norman W. Henley Publishing Co. Cloth; 4½ × 7 ins.; pp. 352; 117 illustrations in text. $2, net.

Earlier editions of this book, which was first published in 1898, have been reviewed in Engineering News, Dec. 10, 1903, and April 18, 1907. In the present edition, the 25th, both the contents and the physical make-up have been considerably revised. The book has been reset in a slightly smaller type but with wider spacing between lines and with the questions in black-face type instead of italics. The general result is to make the text easier to read and to make it easier to find a given question by glancing through the pages. Incidentally there is now more text on a page, and therefore fewer pages in spite of the additions made. The size of the type page has been kept about the same as in the 1907 edition, but the outside dimensions have been decreased by reducing the margins. This, with the provision of covers with rounded corners, makes the book convenient for the pocket. The quality of paper is somewhat bet- than in the 1907 edition, which has made it p- sible to place all of the numerous diagrams and drawings and even the colored charts in the bo- of the text.

The changes in the text consist l the addition of questions and answers on th new type of brake equipment for passenger c s which has been brought out recently by the Westinghouse company to meet the requirements of increased weight of cars. This material, together with that on other new developments given in an appendix in earlier issues, has been incorporated into the main body of the text, suitably distributed in the various chapters. As the book now stands, it covers the various phases of its subject progressively from the older and simpler construction to the newer and the more complex.

In addition to the descriptive matter on brakes, pumps, valves and the signal system, there is a chapter of practical formulas and rules for the air-brake inspectors, one on braking power and leverage, and one on train inspection and train handling.

Mill Buildings.

A TREATISE ON THE DESIGN AND CONSTRUCTION OF MILL BUILDINGS AND OTHER INDUSTRIAL PLANTS.—By Henry Grattan Tyrrell, C. E., (Toronto University); Author of "Mill Building Construction, 1906"; "Concrete Bridges and Culverts"; "History of Bridge Engineering," etc. Chicago and New York: The Myron C. Clark Publishing Co. London: E. & F. N. Spon, Ltd. Cloth; 6 × 9¼ ins.; pp. 490; 652 text figures. $4, net.

In revising a less pretentious book on the same subject, written ten years ago, Mr. Tyrrell has produced not only a new book, but one that affords by far the largest and best collection of practical information on mill buildings yet published. Nearly every point that rises up to worry the designer of a mill building finds some sort of mention, and most of them are illuminated by well-made design drawings. Many tables are included, and information on costs is plentifully scattered through the text, one interesting item being a table of current wages (1910) for the various building trades in about 50 different cities.

This fullness and variety of treatment not only constitutes the merit of the work, but also is the principal matter to be emphasized in a review, as there are no individual features of novelty of method to call for comment. On the other hand, the arrangement of the information given is deficient in orderly detail grouping, as a result of which fact the user will have to refer frequently to the index. In spite of this, the book will prove a necessary manual to every steel designer, and should also appeal largely to all students of structural engineering.

The chief omission is stress analysis, which the author deliberately left out of the book to make more room for design data. We regard this as a commendable step, since both analytical and graphical methods are amply covered by other books. It has come to be a fashion in recent years to incorporate in a book on design of a particular form of structure a full statement of the elementary statics applicable to the subject, a proceeding of very doubtful utility. In the matter of mill buildings, particularly, it should be left to the individual judgment of the engineer how the principles of stress analysis in frames ought to be applied to the numerous complexities of the framework. The book before us gains in value by devoting itself wholly to general arrangement, constructive details, and working data.

Announcement has just been made of the proposed publication of a new periodical entitled "Vocational Education," a bi-monthly devoted to the broad field suggested by that title. The staff of editors is made up of men directly interested in the vocational or manual training of youth, and is largely drawn from the faculties of our manual training and engineering schools of this country. The numbers will appear in the months of September, November, January, March and May, the initial number to be dated September, 1911. The annual subscription price is $1.50. The Manual Arts Press, Peoria, Ill., is the publisher.

German Literature.

THEMEN DER PHYSIKALISCHEN CHEMIE.—Auf Veranlassung des Vereins deutscher Ingenieure an der Technischen Hochshule, zu Braunschweig gehaltene Vorträge. By Dr. Emil Baur, Professor an der Techn. Hochschule in Braunschweig. Leipzig, Akademische Verlagsgesellschaft m. b. H. Paper; 6¼ x 9½ ins.; pp. 113; 52 text figures.

RADIUMNORMALMASSE UND DEREN VERWENDUNG BEI RADIOAKTIVEN MESSUNGEN.—By E. Rutherford. Deutsch von Dr. B. Finkelstein. Leipzig: Akademische Verlagsgesellschaft, m. b. H. Paper; 6 x 8½ ins.; pp. 45; three text figures.

DIE GRUNDLEHREN DER HOEHEREN MATHEMATIK.—Zum Gebrauch bei Anwendungen und Wiederholungen Zusammengestellt. By Dr. Georg Helm, Geheimer Hofrat, Professor an der K. Techn. Hochschule Dresden. Leipzig: Akademische Verlagsgesellschaft m. b. H. Paper; 6 x 9½ ins.; pp. 419; 387 text figures.

The far-reaching importance of physical chemistry to technologic operations has become known only in very recent years. The main principles of chemical action have indeed been formulated only in the last quarter century, and the science of physical chemistry is barely on an independent footing. But in its development the practical importance of its teachings became apparent at every new step, and in many branches of applied science they are of essential importance. To bring out the relations of the science to the phenomena of practice, however, requires a kind of genius for clear and attractive presentation. Prof. Baur in his lectures gives evidence of such genius, and they make a corresponding appeal to the ambitious reader. It is worth note that the lectures here published were delivered at the instance of an engineering society (the Verein Deutscher Ingenieure). The subjects of the lectures are: Reaction equilibrium, mass action and reaction energy; Voltaic cells; Blast furnace reactions; Some chemical manufacturing processes; Catalysis; Explosion (of gases); Explosives; Metallographic study of compounds; Colloids and adsorption. In one chapter or another something of special interest will be found by everyone who is at all interested in scientific study.

A more remotely scientific work is represented by the German translation of Rutherford's work on standards for measuring radioactive values. The translation is readable in every respect, but American readers will doubtless go to the original English.

Helm's somewhat synoptic manual of higher mathematics should engage the attention particularly of those who favor teaching as one single, coherent subject analytic geometry, calculus and related higher developments. This view is finding expression in an increasing number of text-books, and apparently will in time prevail in all mathematical instruction. The book is also adapted to serve as a useful reference compendium of many branches of mathematical study with which the non-mathematician comes in contact but rarely.

The United States Geological Survey has recently issued the Birmingham, Ala., folio of the Geologic Atlas of the United States. The Birmingham quadrangle covers 992 sq. miles, mostly in Jefferson and Blount counties, and includes an important coal and iron mining district.

Bulletin 431 of the Geological Survey contains a number of short reports and papers on petroleum, natural gas, coal and lignite in various parts of the country. There are five papers on petroleum and natural gas and seven on coal and lignite. These reports cover those fields investigated by the Survey during the year 1909. The present volume is the fourth of the series. Bulletin 470-D is an advance chapter on the lead and copper deposits in the Bear River Range, Idaho and Utah, and the lead and zinc deposits in northeastern Washington.

Bulletins Nos. 458, 459, 462, 463, 464, 469 and 473 give the results of the level operations of the Survey from 1896 to 1909, inclusive, in the following States, respectively: Arkansas, Louisiana and Mississippi; Missouri Oregon, Arizona, New Mexico, North Dakota, Kansas and Nebraska. Bulletin 462 covers Texas from 1896 to 1910, and Bulletin 477 covers West Virginia for 1909 and 1910.

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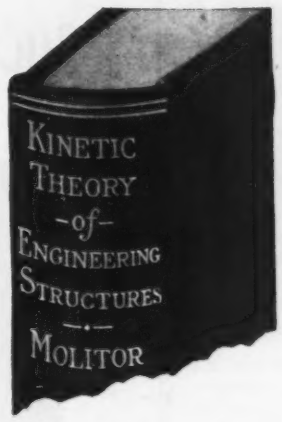

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Some Details of Water Works Construction. By W. R. Billings. 96 pages. $2.00 (8/6).

Water Works for Small Cities and Towns. By John Goodell. 281 pages. $2.00 (8/6).

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Cement and Concrete. By Louis Carlton Sabin. Second edition, revised and enlarged. 584 pages. $5.00 (21s).

Reinforced Concrete. By A. Considere. Second edition, enlarged. 242 pages. $2.00 (8/6).

The Modern Manufacture of Portland Cement. By Percy C. H. West. 280 pages. $4.00.

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Vol. I. **Arch Spans.** 301 pages. $3.00 (12/6).
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Corrosion and Preservation of Iron and Steel. By A. S. Cushman, A.M., Ph.D., and Henry A. Gardner. 375 pages. $4.00 (17s).

Iron and Steel. By Hugh P. Tiemann. 354 pages. $3.00 (12/6).

MATHEMATICS

Engineering Mathematics. By C. P. Steinmetz. 292 pages. 6x9. $3.00 (12/6).

Mathematical Handbook. By Edwin P. Seaver. 290 pages. $2.50 (10/6).

Handbook of Mathematics. By J. Claudel. 708 pages. $3.50 (15s).

The Construction of Graphical Charts. By John B. Peddle. 109 pages. 6x9, illustrated. $1.50 (6/6).

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Water-Supply for Country Homes.

HOME WATERWORKS.—A Manual of Water Supply in Country Homes.—By Carleton J. Lynde, Professor of Physics in MacDonald College, Quebec. New York: Sturgis & Walton Co. Cloth; 5 x 7½ ins.; pp. 270; 106 text figures. 75 cts., net.

Writing for "The Young Farmer's Practical Library" the author of this little book has presented in simple language a general outline of systems of water-supply suitable for individual houses not within reach of municipal water-works systems. The bulk of the volume, however, consists of a description of various kinds of pumps and devices for driving such of them as are not worked by hand, together with an exposition of the physical principles involved. There is also included with this matter the same kind of information regarding the storage and delivery of water under air pressure and an explanation of the principles of siphonic action.

A relatively small portion of the volume treats of the value of water indoors, "kitchen equipment" and various sources of water-supply. These subjects are presented before the portion of the book relating to pumps and allied matters. Toward the end of the book there is a brief chapter entitled "Plumbing and Sewage Disposal," and also a classified list of firms dealing in water-supply and plumbing materials.

It is questionable whether in a book for the young farmer so much space should be devoted to an exposition of the physical principles involved in the operation of pumps, especially when such matters as supporting water tanks are passed by with a few general words of caution as to the importance of making the supports ample.

The author explains the brevity of the chapter on "Plumbing and Sewage Disposal" by stating that the subject will be covered in another volume of the series, "Health on the Farm." The portion of the chapter (5 pp.) dealing with sewage disposal hardly belongs in a book on waterworks, and is so inadequate as to make it necessary to look elsewhere for full information. Moreover, the author is not always clear or accurate in the little that he does say and some of his statements are misleading.

Some of the remarks on cesspools need explanatory qualification, to say the least. The paragraphs on the septic tank give further currency to the notion that the septic tank is an all-inclusive and perfect system of sewage disposal, a notion which has already caused much needless expense and spread nuisances all over the country. The paragraphs also contain other misleading or out-and-out wrong statements. We quote two paragraphs, as follows:

> The best method of disposing of sewage so far devised is by means of a septic tank.
>
> The septic tank system (Fig. —) as commonly built, consists of a tank with two chambers and a tile drain such as that described in Chapter II. The sewage enters the first chamber and fills it to the level of the outlet C. In time a layer of scum forms on the top of this liquid. This scum is the home of millions of anaerobic bacteria, the action of which is to liquify all organic solid matter floating on the surface.

A little further information is given at this point regarding tiles for sub-surface distribution, the size and material of tank, etc.

The statements regarding both cesspools and septic tanks are likely to lead the "Young Farmer" astray. It is to be hoped that the promised volume on "Health on the Farm" will set him right, but as the author announced is (apparently) a doctor of medicine the chances are good that he will go even further astray in engineering matters than has Prof. Lynde. It seems pertinent to inquire, when will the publishers of popular sanitary literature safeguard themselves and the public from the errors and misleading statements of men whose knowledge of sanitation is often unsound and whose knowledge of engineering is little or nothing?

THE ENTERIC FEVER "CARRIER."—Report to the Local Government Board (London) on Public Health and Medical Subjects. By Dr. J. C. G. Ledingham. London: Wyman & Sons, Ltd. (Fetter Lane, E. C.) Paper; 6 x 9½ ins.; pp. 138; S. 1, net; American price, 40 cts., net.

An American abstract of this valuable review of prosent literature and knowledge of typhoid "carriers" was noted in this Supplement for April 13, 1911, p. 49. The report deserves the attention of all who are attempting to follow the subject in detail.

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The Annual Report of the Chief of the Weather Bureau for 1909-1910 has just been issued. The report contains the usual summary of weather conditions in the United States for the year 1909. The Weather Bureau had 1,213 paid stations and 3,800 cooperative stations in operation during 1909. A table is given of the geographical positions of the observing stations which might prove useful to engineers, as it gives the latitude, longitude, elevation and difference in time of various points scattered throughout the United States and surrounding countries.

The City of Seattle, Wash., Mr. R. H. Thomson, M. Am. Soc. C. E., City Engineer, has issued a small paper bound book of standard plans and specifications covering grading for walks and streets, curbs and gutter construction, sidewalks, stairways, retaining walls, sewers, water mains, paving, etc. The book is 4½x9 ins., printed on thin paper with a flexible cover and is therefore in convenient shape to carry in a pocket. A very complete index makes it but the work of a moment to find any desired detail. The book contains a good deal of information in a very small space.

Management Engineering
or
Scientific Management

Scientific management has recently received a great deal of attention in the daily press and general magazines. One important newspaper made the editorial comment that no development in the world of engineering has ever arrested public attention to the same degree as has the new science of management, or management engineering. The first book published on this subject is

"Cost Keeping and Management Engineering"

By Halbert P. Gillette and Richard T. Dana, Members American Society of Civil Engineers.

Ten fundamental laws of scientific management are announced and discussed by the authors, and then follows a treatise on cost keeping as applied to engineering construction.

This book has had a very large sale since its publication two years ago. It contains 360 pages (6x9 inches) and 184 illustrations. The price is $3.50, net, postpaid.

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SECOND INTERNATIONAL ROAD CONGRESS, BRUSSELS, 1910.—Report of the Proceedings of the Congress. Paris: Permanent International Association of Road Congresses, 1 Avenue d'Iena (M. Mahieu, Secy.) Cloth; 6¼ x 9¾ ins.; pp. 502; 11 plates.

The official Proceedings of the sectional and general meetings of the Brussels Congress, named above, are given in detail in this volume. There are also included accounts of the various excursions and social functions participated in by the members of the Congress. The papers presented at the Congress are not included in the volume before us, having already been previously issued.

Publications Received.

ADMINISTRATIVE REPORT ON THE RAILWAYS IN INDIA: 1910.—By the Railway Board. Simla, India: Pub. Doc. Boards; 8⅛ x 13 ins.; pp. 333; two folding maps and one diagram of statistics in pocket of cover.

BUILDING IN LONDON.—A Treatise on the Law and Practice Affecting the Erection and Maintenance of Buildings in the Metropolis. By Horace Cubitt, A. R. I. B. A., P. A. S. I. With special chapters dealing respectively with The Cost of Building Work in and around London, by H. J. Leaning, F. S. I., and The Valuation, Development, and Rating of London Property, by Sydney A. Smith, F. S. I., Gold and Silver Medallist, and "Driver" Prizeman of the Surveyors' Institution. London: Constable & Co., Ltd. (10 Orange St., Leicester Sq., W. C.) Cloth; 6½ x 10 ins.; pp. 800. 31s. 6d., net; American price, $12.50, net.

BUREAU OF STATISTICS, MUNICIPAL DEBTS AND REVENUE DEFICIENCIES—Report by Harvey S. Chase, Certified Public Accountant. Boston, Mass.: Pub. Doc. Paper; 6 x 9 ins.; pp. 16.

CANADA DEPARTMENT OF MINES, MINES BRANCH.—Hon. W. Templeman, Minister. Report of the Division of Mineral Resources and Statistics on the Mineral Production of Canada, 1909. John McLeish, B. A., Chief, Division of Mineral Resources and Statistics. Ottawa, Canada: Pub. Doc. Paper; 6½ x 9¾ ins.; pp. 291.

CHEMINS DE FER FUNICULAIRES TRANSPORTS AERIENS.—By A. Lévy-Lambert, Ingénieur, Chef des Services de l'Eclairage et du Chauffage, du Chemin de fer du Nord. Paris: Gauthier-Villars, Imprimeur-Libraire (Quai des Grands-Augustins, 55). Paper; 6½ x 10 ins.; pp. 526; 213 text figures. Francs, 15; American price, $4.50 net.

COMMISSION OF CONSERVATION, CANADA.—Hon. Clifford Sifton, Chairman. Annual Report, Including a Report of the Proceedings of the Second Annual Meeting Held at Quebec, Jan. 17-20, 1911, and of the Dominion Public Health Conference Held at Ottawa, Oct. 12-13, 1910. Ottawa, Can.: Pub. Doc. Cloth; 6¾ x 10 ins.; pp. 230.

COMMONWEALTH BUREAU OF CENSUS AND STATISTICS, MELBOURNE.—Bulletin No. 4: Finance. Summary of Australian Financial Statistics, 1901-1910. Published under the authority of the Minister of Home Affairs, by G. H. Knibbs, C. M. G., Commonwealth Statistician. Melbourne, Australia: Pub. Doc. Paper; 8 x 13 ins.; pp. 69.

THE CONFLICT BETWEEN FEDERAL AND STATE REGULATION OF THE RAILWAYS.—Bulletin No. 15, Bureau of Economics; Logan G. McPherson, Director. Washington, D. C.: Pub. Doc. Paper; 6 x 9 ins.; pp. 13.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.—Papers and Transactions for 1910 and Proceedings of the Annual Meeting at New London, Feb. 14-15, 1911. New Haven, Conn.: The Society (J. Frederick Jackson, Secy.) Paper; 6 x 9 ins.; pp. 146; many text illustrations.

CREOSOTED WOOD BLOCK PAVING IN CHICAGO.—By Charles K. Mohler, Consulting Engineer, Chicago. Prepared for the Loop Protective and Improvement Association. Paper; 6 x 9 ins.; pp. 62; illustrated.

ELASTIZITAET UND FESTIGKEIT.—Die für die Technik Wichtigsten Sätze und deren erfahrungsmässige Grundlage. By Dr.-Ing. C. Bach, K. Württ. Baudirektor, Professor des Maschinen-Ingenieurwesens an der K. Technischen Hochschule Stuttgart. Sechste, vermehrte Auflage. Unter Mitwirkung von Prof. R. Baumann an der K. Technischen Hochschule Stuttgart. Berlin: Julius Springer: Cloth; 6 x 9½ ins.; pp. 642; 20 plates and many text figures. 20 marks; American price, $8, net.

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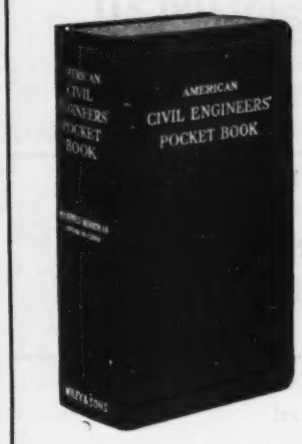

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